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LECTURES

ON

THE ACTION OF MEDICINES

BEING THE COURSE OF LECTURES

ON

PHARMACOLOGY AND THERAPEUTICS

DELIVERED AT ST. BARTHOLOMEW'S HOSPITAL DURING THE SUMMER SESSION OF 1896.

BY

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L. B.

ERRATA.

p. 196, 19 lines from bottom, *for* " furfurol " *read* " furfural."

p. 197, 6 lines from top, *for* " furfurol " *read* " furfural."

p. 235, 5 lines from top, *for* " antifibrin " *read* " antifebrin."

p. 270, 11 lines from bottom, *for* " broncophony " *read* " bronchophony."

p. 327, second line of title, instead of " Guides wits' use " *read* " Guides to its use."

p. 513, 12 lines from top, *for* " antifibrin " *read* " antifebrin."

TO

SIR TREVOR LAWRENCE, BART.,

TREASURER OF ST. BARTHOLOMEW'S HOSPITAL,

IN RECOGNITION OF HIS LOVE OF SCIENCE, ADMINISTRATIVE ABILITY, AND GENEROUS LIBERALITY.

AS WELL AS

IN GRATEFUL ACKNOWLEDGMENT OF MUCH PERSONAL KINDNESS,

THESE LECTURES

ARE DEDICATED

BY HIS ATTACHED FRIEND

THE AUTHOR.

TO THE READER.

I MAY, perhaps, be pardoned for saying a word or two of introduction to the following Lectures in regard both to their matter and to their manner. They are intended to give a general sketch of the mode in which drugs act upon the body, and they are arranged very much in accordance with the schedule for the examination in Pharmacology which was instituted by the Royal Colleges of Physicians and Surgeons, but which was abolished before any examination had actually been held. In the discussion which arose in regard to this examination previous to its abolition, much dislike of the schedule was expressed, although it had been introduced for the purpose of limiting the work that the student had to do, instead of increasing it. The schedule is here reproduced, and it will be seen that it may be very fairly used as a table of contents to the present book.

In regard to the manner of these Lectures, I may say that I am fully aware of the objections which may be brought against it. I acknowledge at once that the Lectures are imperfect. They are redundant in some parts, and scanty in others; they are not well adapted for the purpose of cramming, and any man who tries to pass an examination upon them alone will not be at all likely to get the maximum number of marks. But I do not think that lectures are intended for the purpose of cramming. Their use is not to supply the student with all the information he needs, but to awaken his attention, to excite his interest, to impress upon him certain points which will form a nucleus for his knowledge, and around which he may afterwards group more information. The first courses of lectures that I gave, in 1870 and 1871, were the fullest, the most complete, and, from the examination point of view, the most satisfactory. They were carefully written down and read aloud to the students, but, as I soon found out, students do not like read lectures. Moreover, the amount of information I gave to them in the hour was far more than they could comfortably take up, and it seemed to me that even the best of them, in trying to grasp too much, got hold of too little, and the lazier ones did not even make an attempt. I then began to reconsider the matter, and thought of Solon's answer in regard to the laws which he had given to the Athenians. "Are those the best laws you can frame?" said his questioner. "No," said Solon, "but they are the best laws that the Athenians can keep." It appeared to me that Solon's advice had been taken also by a London preacher, who went to a friend of mine learned in history. "I am going to preach a sermon upon war," he said; "I want you to give me some facts." My friend rattled off half a dozen pieces of information. "Stop," said the preacher; "that is as much as my congregation will hold." In my lectures I have tried to follow this preacher's example, and not to stuff into each lecture as much information as could be given in the hour, but as much as I thought my audience would take up. Whether I have been right or wrong in so doing I must leave to the readers of these Lectures to judge.

It is with much pleasure that I acknowledge my obligation to Mr. M. Donaldson for the accuracy with which he took down the lectures in shorthand as they were delivered, and to Dr. Tunnicliffe for his kind assistance in revising them.

T. LAUDER BRUNTON.

SCHEDULE OF PHARMACOLOGY.

The Action of Medicinal Agents on the Body in Health and Disease.

The range of the Examination will extend to the following Medicinal Agents :—

The Application of Heat and Cold by both dry and moist methods.
Bleeding, Leeching, and Cupping.
Counter-irritation.

The Pharmacopœial Drugs and preparations defined in the Schedule of Pharmacy.

The scope of the Examination, as regards the above Agents, will be held to include any of the following Actions :—

Caustic action ; the production of eschars, blisters, and pustules ; the formation of protective coatings.

Actions on the peristaltic movements of the alimentary canal and on the secretions of the glands connected with it ; on the processes of digestion ; on the appetite. The production and arrest of nausea and vomiting.

Actions on the composition of the blood ; on its corpuscles and leucocytes ; on cell movements ; on nutrition and metabolism.

Actions on the muscular walls of the heart and its intrinsic ganglia ; on its accelerator and inhibitory apparatus ; on the muscular coats of arteries and arterioles ; on the blood pressure and blood flow. Rubefacient and irritant action ; astringent action ; arrest of hæmorrhage.

Actions on the processes of inflammation, acute and chronic.

Actions on absorption ; on the absorption of serous and inflammatory effusions.

Actions on the secretory apparatus of the kidneys and the composition of the urine.

Actions on the cutaneous and mammary glands.

Actions on the movements of respiration and the secretion of the respiratory tract.

Actions on the higher cerebral functions. The production and prevention of sleep.

Actions on the sensory functions of the nervous system. The production of anæsthesia, local and general. The relief of pain. Actions on the special senses.

Actions on the reflex and motor functions of the nervous system and on muscular tissue. The production and arrest of spasm, convulsions, and cough.

Actions on the intrinsic muscles of the eye.

Actions on the gravid uterus ; on the catamenial flow.

Actions on the temperature of the body ; on pyrexia and hyperpyrexia.

Actions on specific *materies morbi* ; on microbes and ferments ; on the processes of putrefaction and infection.

Antidotal action with regard to other drugs.

It will also include—

The channels of absorption and elimination of drugs.

The principles of dosage : Idiosyncrasy, Accumulation, Toleration, Habit.

The usual toxic effects of—

Phosphorus.
Drugs containing Arsenic, Mercury, and Lead.
Iodides, Bromides, and Salicylates.
Chloroform and Chloral Hydrate.
Morphine, Atropine, Strychnine, and Quinine.
Acetanilide and Phenazone.
Digitalis, Ergot, Camphor, Oil of Turpentine, and Cantharides.

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LECTURES

ON

THE ACTION OF MEDICINES,

BEING THE COURSE ON

PHARMACOLOGY AND THERAPEUTICS.

AT ST. BARTHOLOMEW'S HOSPITAL,

1896.

LECTURE 1.

Introductory—Vital processes—Action of drugs—Circumstances affecting the action of drugs—Absorption—Excretion—Methods of administering drugs.

GENTLEMEN,

The great object of medicine is very well put forth in the prayer which the hospitaller offers up at various solemn functions in this hospital. He prays for "health and ease to the poor patients." Health, ease, and prolongation of life are the three objects for which the aid of the physician is usually sought. Not unfrequently he is able to obtain all three for his patients by merely regulating their habits and mode of life. For those disturbances of functions or of organs which lessen our comfort or ease, and are known by the name of "diseases," are very frequently due to the wrong indulgence of patients in many habits; some injurious in themselves, and others good in themselves but injurious through excess. There are various recommendations which a doctor gives to his patients, and which are very hard to get carried out. One of those is work for those who will not take it; another, rest for those who cannot get it; yet another is restraint of the appetites. Now the appetites in themselves are given to man for the benefit either of the individual or of the race. Their indulgence in moderation is good and right, but in excess they are injurious. It frequently happens that a physician's duty is to tell his patients to do precisely what they like least, because it is the liking the patients have for certain things which leads them into excesses, and it is those excesses which the doctor has to restrain.

The appetites, however, are not entirely to be disregarded, for sometimes they point the right way, and the doctor must not be too positive in completely forbidding anything that the patient desires. This was the usual plan followed in years gone by. If the patient wished for anything, the doctor was sure to say *that* was the thing the patient must not have; and therein I think the doctor was wrong. I well remember hearing that an uncle of mine, who was out in the West Indies, got yellow fever, and when he was at his very worst he suddenly called out for a draught of porter. The negro servant in attendance said: "If massa drink porter, massa die;" but massa thought that, as he was going to die at any rate, he might just as well have the porter; so he got it, drank it, and began to get well straight away. I well remember, too, when I was a child suffering from measles, how the raging thirst made me call out for a little cold water; but this cold water was sternly forbidden, and not a drop could I have, because the doctor said that it might "throw in the rash." Now these prohibitions of the doctor are frequently well grounded, and if I had drunk a very large quantity of cold water at once it might not have been good for me, but a little cold water would have certainly done no harm, and now-a-days we allow cold water to quench the thirst of a fever patient, and by doing so we probably do our patient much good. But sometimes the appetites in disease, as well as health, give wrong indications, and at the end of a serious disease, such as typhoid fever, perhaps the patient may have a craving for something. A craving for solid food he is sure to have, and if this be gratified too soon the ulcers in his intestines will in all probability be irritated, his temperature will rise, his recovery will be retarded, and death may even ensue. But besides a general craving for solid food he may have a specific craving for some particular article of food such as bacon, or for salt fish, and if he gratified this craving he would very probably do himself much harm. Yet the craving is based on a want of the organism, and is probably not really for the salt fish or for the bacon in themselves, but for the salt which they contain, and if we give him a little salt on the tip of his tongue it will relieve the craving and do him no harm, but positive good. Such cravings are seen in animals also, and before the herds of buffalo which used to roam over the prairies of America were destroyed, whole herds would sometimes stampede, as it was termed, and rush wildly in the direction of certain places where rock-salt cropped up out of the ground, and there the buffaloes would lick the salt. Now they had no notion whatever of the reason why they did this; it was mere instinct on their part, but of late years we have been taught by physiological chemistry that what they really wanted to do was to restore the balance of salts in their organism; that feeding, as they did, upon the prairie grasses containing a quantity of potash and very little soda, their bodies became poor in soda, and in order to restore the balance between the potash and soda salts they made for the "salt licks."

One very often finds, too, that a change of air involving, as it does, not merely change of air, but change of water, circumstance and food, is beneficial, and what seems at first sight curious is that people who live inland usually go in their holidays to the seaside, whereas, those who live at the seaside long to go inland. It seems as if the change does them good by restoring a proper balance in some way.

Medical Systems.—Doctors have been summoned from the earliest history of the world to give relief to their patients, and they have acted in their day upon the ideas which they had in their heads. It was their ideas which governed their actions. Sometimes those ideas were right, sometimes they were wrong; and we may divide the various systems of medicine into those of (1) Fancy, and of (2) Fact. Amongst the fancies that doctors used to have was one that various plants were stamped by their outward appearance in relation to their use in medicine. For example, the mandrake had a long, bifurcated root, so that the two parts of the root resembled the legs of a man, and the whole root had a very fair resemblance to the human body. It was, therefore, supposed that if the mandrake were administered to a female who desired children it would bring about conception.

Other doctors, again, finding that these vague fancies had no sort of use whatever, depended entirely upon the results of experiment. Certain things were tried, were found to fail and were given up; others were tried and found to succeed and, therefore, their use was continued. But even in this kind of treatment, which is known by the name of "empirical," there were various fallacies, because in cases that seemed to be alike the conditions were frequently perfectly dissimilar, and the results of the administration of medicines or of other treatment were, therefore, not always alike.

We find this mode of treatment is still carried on, both by doctors and by patients at the present day. We find that patients will pass on to a friend a prescription which has done them good, and sometimes, I am sorry to say, doctors also will do very much the same thing, disregarding the fact that in the different cases the prescription will have very different results, and while it is beneficial in one it will be injurious in another.

I never hear of a prescription being handed on in this way without thinking of the old story of the two donkeys. You may not all have heard of it, and it will explain to you what I mean, perhaps, better than any other words of mine. Two donkeys lived in a stable. One day one of the donkeys was taken out by its master and laden with a lot of salt. On the journey they had occasion to ford a river, and the river being flooded the water reached the saddle-bags and melted the salt, which, of course, then poured out of the saddle-bags, so that when the donkey reached the other side it found, to its great delight, the weight on its back had almost entirely gone. It came back very much delighted, and told the other donkey what had happened. It said: "If the master takes you out with a load, be sure that you go through the water, because it will take the load quite away." The next day the other donkey was taken out and laden also. It made a long detour to try and get through the water. It went through the water, but to its great disgust it found that instead of its load disappearing it became many times heavier than before, because the load on the second donkey consisted not of salt but of hay, which absorbed the water instead of melting, and thus the last state of that donkey was ten times worse than the first. And so it may be with patients who swallow physic, either because they have seen it puffed in an advertisement or because a friend has handed them a prescription without knowing whether the physic or the prescription is suited to their own particular case or not.

Now sometimes one is tempted to regard the complex of symptoms presented by patients as an entity, to dub it with a name, and to treat the name instead of treating the patient. Cases have occurred in which the doctor, after having diagnosed the case and named the disease, has systematically treated it instead of treating the patient, who has remonstrated saying: "These drugs don't suit me, doctor; I am getting worse and worse instead of better." But the doctor thinks they ought to do good, and he goes on. Sometimes the patient becomes indignant, and refuses to be treated any longer; sometimes he will go on meekly submitting, but getting no better, until at last some change takes place either in the doctor's ideas or in the patient's circumstances, and he may possibly recover.

Rational Medicine.—Both the fancies and the facts which guide doctors in their treatment may be good enough in themselves, but they are both liable to great failures, and the proper method is to combine the two: (1) to correct the fancies by facts, and (2) to string the facts together by fancy or theory.

It is exceedingly difficult to connect together various facts so as either to remember them or to utilise them, unless you have some guiding idea which will serve as a thread to string them together; and it is with the object of having such a thread that we try to get a theory which will connect the facts together as far as possible, and thus to arrive at a rational system of medicine.

But a rational system of medicine depends, first of all, upon a knowledge of the nature of the disease, or *pathology*. It depends, secondly, upon a knowledge of the action of the remedies that are to be employed in the disease, or *pharmacology;* and the knowledge of those two subjects depends upon a knowledge of the healthy structure of the body, or *physiology;* and physiology in its turn depends upon chemistry and physics. So you see that the treatment of patients according to a rational method requires a very wide substratum of general knowledge. Formerly all these subjects which I have mentioned were taught in one class by one teacher under the name of Institutes of Medicine; but as the various subdivisions became gradually elaborated, and the knowledge that was to be imparted under each of them increased, it was found impossible for one man to teach the whole. Now we have teachers of chemistry, of physics, of physiology, and of pathology.

It may be said that the action of drugs could very well be taught along with their application; that both the action of drugs, or *pharmacology,* and the application of drugs in disease, which is known by the name of *therapeutics,* could be taught along with medicine. The objection to this is simply that there is not time—that in the subject of medicine there is so much to be done in the way of teaching semiology, or the significance of symptoms, and pathology, or the nature of the diseases, as well as treatment, that it is impossible to enter into the action of all the drugs that are to be used.

And yet it is very necessary that an exact knowledge of drugs should be possessed by every man who is going to be a successful practitioner. Some men think that a general knowledge of the action of drugs is quite sufficient, and that if a man know, for example, that digitalis is a " cardiac tonic " and a " diuretic " it is quite enough. But if a doctor knows only so much he may be led into very grievous error, because I have seen a case in which the urine had completely stopped, the heart was feeble and exceedingly irregular, and the man was almost pulseless. Yet this patient had been taking digitalis for a length of time. One who only knew digitalis as a " cardiac tonic " and " diuretic " would be likely to say, " This man has a feeble pulse and scanty urine, he ought to have more digitalis;" and would probably have increased the dose. The result would have been that the patient would have died, because those symptoms which I have detailed to you were really the effect of an overdose of the digitalis which the man had been taking.

Without a knowledge of the exact mode in which drugs act in different quantities, it is impossible for you to know how far to push a drug and when to stop; and it is sometimes only by pushing a drug to the very verge of danger that we are able to succeed. I have saved a man by pushing strychnine until I made his fingers jump, knowing, as I did, that without this the man was doomed to die; and, if I did give him an overdose, the worst I could do was to shorten his life a very little. For I could subdue the symptoms by giving chloroform, and thus I would cause him no pain. I could hardly shorten his life, because he had not at the outside two hours to live, and by pushing the drug to the very utmost I succeeded in gaining what I wanted. I daresay some of you have tried occasionally to unloosen an ordinary double knot, which ought to yield when one of the strings is pulled. You pull and pull, but it seems to get tighter and tighter. Sometimes in despair one gives up, and tries to undo it slowly and carefully; at other times one simply gives it a violent tug, and if one gets hold of the right string the knot yields at once. Sometimes it is just the very last tug that makes all the difference, and something similar occurs in medical practice. There are men who are ignorant of medicine, and yet sometimes succeed when better trained men fail, because in their ignorance they will push drugs to an extent that the better trained men dare not venture to do. At the same time those ignorant men run a great risk of killing their patients, so that, perhaps, upon the whole it is the safer thing that you should sometimes fail by too great care than that you should ignorantly push your drugs to the extent of killing your patients. But it is only a thorough knowledge of the action of drugs, or pharmacology, that will enable you to do the maximum of good with the minimum of harm.

Now the subject of drugs is one which has been taught for many years under the name of "Materia Medica;" but materia medica, like many other subjects, has got divided up into two divisions, each of which is further subdivided into two subdivisions.

The first division deals with the collection, preparation, and compounding of drugs. It requires no knowledge of the functions of the human body either in health or disease, and is the proper province of the chemist and pharmacist.

The second division deals with the actions of drugs upon the human body, and their uses in the treatment of disease. This division requires an intimate knowledge of the bodily functions, and is the province of the physician.

The first division includes the two subdivisions (1) Materia Medica proper, and (2) Pharmacy. By Materia Medica proper we mean a knowledge of the crude drugs—their botanical and geographical origin, their appearance and composition, their recognition, and the methods of detecting impurities in them. This used to be a very great burden to the memories of students, and it is a part of the subject which I have been trying, as far as I possibly could, ever since I became lecturer on materia medica, to abolish, because I consider it of almost no practical importance. For example, the plant which yields elaterium has changed its botanical name three times since I began to study medicine, but that has not altered in the very least the action of the product which is obtained from it. So that since a man might possibly be rejected for not knowing some botanical names, I think this part of the subject is both useless and objectionable, and the sooner it is abolished the better.

Pharmacy.—Pharmacy deals with the making up of drugs for the purposes of administration. It is obviously impossible to administer many of the roots or leaves in a crude state, and we wish to get from them their active principles, and this is one subject with which pharmacy deals. But not only have we to obtain from them their active ingredients, we have to combine these and make them palatable, and we have to take care, for example, that by the admixture of two active things we do not destroy the properties of both. When in a mixture this occurs, we call the substances incompatibles. To give you an example of this, I may mention that we have two liniments, both of which are useful in themselves—viz., compound camphor liniment, the active principle of which is strong ammonia; and acetic turpentine liniment, the active principle of which is strong acetic acid. Ammonia in itself is a powerful irritant, and when rubbed over the chest tends to relieve cough and pain. Acetic acid when rubbed over the chest has a similar action, but if we combine the two we destroy both the ammonia and the acetic acid. Acetate of ammonia is formed, which has little or no local action, and the activity of the liniment is entirely destroyed.

Pharmacy includes, then, a knowledge of incompatibilities, and it ought to include a knowledge of how to make medicines agreeable. It is one of the great disadvantages of prescribing, as compared with the actual dispensing of medicines, that the doctor who simply prescribes, although he may know precisely the drugs which are likely to be useful and the doses in which these drugs should be given, does not know precisely how the mixture tastes; whereas a doctor who dispenses his own medicines can taste the mixture before it is sent out, and by adding some flavouring ingredient or other he may make it pleasant to the patient, while a similar mixture made up from a prescription might be quite disagreeable. But dispensing by doctors has fallen more and more into disuse, and we are thus rendered more and more dependent upon chemists. It is, however, a disadvantage that we should depend entirely on chemists for the mixtures or pills we prescribe, because this tends to bring us back again to the mode of treatment that I have been talking about before—viz., that of simply giving a name to the disease and then prescribing for it without regard to the individual patient. Thus, when diarrhœa occurs, instead of finding out the cause and using the proper treatment, hygienic, dietetic, medical or surgical, as the case may require, Messrs. So-and-So's Diarrhœa Mixture may be given, perhaps, along with Mr. Such-another's Wind Pills to relieve the flatulence. Practice like this not only tends to throw medicine back in itself, but to throw it out of the hands of the doctors into the hands of the patients, who begin prescribing for themselves from the wholesale lists which are sent out by the chemists and druggists, and this is bad for everyone concerned.

It is, then, very strongly advisable that men should know something practically about pharmacy, and we therefore have in this school a class for practical pharmacy, which is intended to make men acquainted with the modes of preparing drugs for use, of obtaining active principles, of mixing medicines, and of dispensing them, in fact of supplying the practical knowledge of medicines which men used to get as apprentices in the olden time.

THERAPEUTICS.—The second division of the subject of materia medica as formerly taught, viz., the action of medicines in health and in disease, is now subdivided into two parts. To the one the name of "Therapeutics" has been given. By this we understand the action of medicines and their application in disease, and you will notice that I say here "disease" rather than diseases, because we only can deal in a course of this kind with the general uses of medicines, for the same reason that the physician in lecturing on medicine can deal only with the special application of medicines.

The other part of the action of medicines is sometimes known by the name of "Pharmacodynamics," but this is an awkward word, and for a good number of years the term "Pharmacology" has come to be applied to a knowledge of the action of drugs upon the body either in a healthy or a diseased condition, but apart altogether from their application to particular diseases. When I speak of a diseased condition I mean that under the action of a drug we must know not merely its effect upon the healthy body, but its effect say upon the body in a state of fever. We must know what alteration will be induced in the action of the drug by a higher or a lower temperature than normal, and also by various other conditions, such as the state of nutrition of the body and so on.

PHARMACOLOGY.—The term "Pharmacology" used to mean everything about drugs, and included materia medica, pharmacy, and everything else, but it has now become limited, and I think properly, in the same way as the term physiology. "Physiology" originally meant a study of the whole course of nature, including physics and chemistry, but now it is restricted to a knowledge of the functions of the body in health, while "Pathology" deals with a knowledge of the functions of the body in disease.

RELATIONSHIPS OF LIVING ORGANISMS.—Formerly, we used to look upon man as something entirely different, in the structure of his body, in his mind, and in everything else, from animals and plants. He used to be regarded as the centre of the universe, the sun and the moon were created for his especial benefit. But as knowledge has increased man has fallen from his high estate, and this world is no longer the centre of the universe, nor can we look upon man as entirely isolated and independent. We know that man, like all living organisms, has various functions, and these functions are shared by the highest and by the lowest. The very simplest bit of protoplasm possesses, like man, the functions of eating, drinking, digesting, breathing, and reproducing itself, and in exercising these vital functions the lower organisms frequently interfere with the vital functions in man and cause in him many diseases. We are now, therefore, obliged to take into consideration the life-history of many of the lowest organisms, because their life may alter, imperil or destroy the lives of our patients. It is more especially to the discoveries of Pasteur, that we owe our knowledge, that most of the diseases which are classed as infective are due to low organisms, and that such enormous advances have been made in the prevention of the various plagues and pestilences which used to be so dreaded.

CELLS AND PROTOPLASM.—Now a cell is not a little bladder simply filled with mucilaginous material. It is a real organism

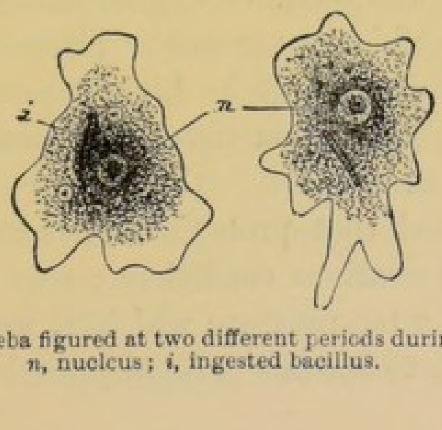

FIG. 1.—An amœba figured at two different periods during movement. n, nucleus; i, ingested bacillus.

with a most complicated structure as you will have learned from your lectures on histology and physiology, and we, to a certain extent, must take the composition of cells into consideration when considering the action of drugs upon them. Cells are formed chiefly of various substances classed under the term "Protoplasm" and contain also the products of the metamorphosis, or of the secretion of that variety of protoplasm of which their cell substance is composed.

These products differ in animals and in plants, the product being to a great extent cellulose in plants, whilst in animals it is some form of proteid material.

A typical example of protoplasm we may say to be the white of an egg. Perhaps the name of protoplasm might be denied to the white of egg, and yet in a fresh laid egg the albumin or white is living; it can be evolved into a chick, whereas if the egg be dipped only for an instant or two into boiling water, although most of the albumin remains fluid, yet that egg is killed and will not hatch if put under a hen. We may, therefore, fairly look on the white of a hen's egg as a fair representative of protoplasm and it can be got in sufficient quantity for all its reactions to be easily studied.

Protoplasm of all kinds has got an appearance very much like white of egg; it is translucent, flows with a certain amount of difficulty, and if you put it into water you will see that it is not uniform in consistence, but that there are streaks through it. [Here the lecturer put some white of egg into a beaker.] The various parts of the white which at first appear to be homogenous are not so in reality, for if you add some water to the egg you will find that the water reacts differently upon different parts of the white of egg, so that you get little white streaks appearing like threads in it. [Here distilled water was added to the white of egg.] Living protoplasm is always slightly alkaline, and it is invariably destroyed if sufficient acid be added to it.

It is to be noted that protoplasm has got the power of becoming adapted to various conditions; that if rapidly heated it may be killed at a temperature which it would readily endure if it were allowed to become gradually used to it. In the same way it may become inured to the presence of various substances which if added in large quantity at once would prove poisonous, but if added gradually will do no harm whatever. And here, too, we find that the same thing holds good for the lowest organisms and for man. What is "one man's meat is another man's poison," and the substances that may be useful for the protoplasm of one set of low organisms may be injurious and are injurious to another.

Now, in the higher animals we find that the cells are associated together, and here again we find that the waste substances of one set of cells seem to be occasionally injurious and occasionally beneficial to other sets of cells. Every cell, whether living free or living in association, digests its food and ejects various products of its excretion. Now, in the struggle for existence between different cells these products of excretion are useful to the cell, and very often enable it to poison other cells which it then proceeds to feed upon.

But at other times when the cells are connected together in higher organisms, what the one cell does is useful to the other. If, for example, we take a sponge with various canals containing water, we have in these canals a number of organisms which are simply amœbæ, not mobile but settled. You can quite readily see that unless there was some provision for bringing water through the canals the cells which are fixed in their places would not obtain either the oxygen or the food they required, but in order to ensure the passage of the water which brings their oxygen and nutriment, some of them are provided with cilia, the to and fro movement of which keeps up a constant flow. What we find in the lowest organisms we find also in the highest. I daresay that many of you may remember that there is one particular part of the human body in which it is very hard to see how a most important structure is going to be supplied with nutriment and how its waste products are going to be removed, viz., the central canal of the spinal cord. But there we find the same arrangement as in sponges; for the cells lining the central canal of the spinal cord are provided with cilia which by their constant waving motion tend to keep up a flow of lymph through the canal, and thus remove waste products and bring fresh nutriment to the nervous structures which surround it.

ALBUMINS.—The chief constituent in protoplasm is albumin; but the albumins in different cells, although they are alike in a general way, yet differ to a considerable extent both in their composition and in their appearance. You all know the difference between the so-called white of a plover's egg, and the white of a hen's egg. When boiled, the white of a hen's egg is really white and opaque, but that of the plover's egg is bluish and translucent. Not only do they differ in appearance, but the composition is also somewhat different, although the chemistry of albumins is so exceedingly difficult that one cannot positively state the exact differences between the two. The two albumins have the common property of being coagulated by heat, they have also the property of being coagulated by various reagents added to them. Some of those reagents cause complete coagulation, which is not readily removed and in some instances is impossible to remove; others cause temporary coagulation, which can be removed with ease. For example, alcohol coagulates albumin, but if the coagulum be treated quickly with water you can generally redissolve it. If the coagulum is allowed to stay for a while under alcohol, however, it becomes harder and permanently insoluble. You will see that when we throw white of egg into alcohol it becomes coagulated. The coagulum will probably disappear to a considerable extent if we now throw in a quantity of water. On doing this you can see that although there are still flakes floating about yet the greater part of the albumin is not coagulated, the coagulum having re-dissolved.

If we add certain other substances, such as chloride of mercury, we get a complete coagulation, which remains more or less permanent.

Now you can easily see that any drug which can coagulate albumin will, if applied in sufficient quantity, destroy any living organism, because it renders the conditions of its life no longer possible. You will also understand that drugs which, instead of completely coagulating albumin only partially coagulate it, may render the functions of the animal body different from what they were before.

In the experiment which I have just shown, you saw that the water did not seem to affect the whole of the albumin in the same way; that some parts became whiter than others. The water seems as it were to have picked out some parts of the white of egg and acted upon them. A similar occurrence takes place in the cells and tissues of the organism.

Action of Drugs.—Some drugs have a universal action, others have a local and limited action.

We can, therefore, divide our drugs into (1) so-called protoplasmic poisons which destroy protoplasm of every kind, and (2) other drugs which seem to have a more or less special affinity for variously differentiated protoplasms. Thus, for example, in the body we have protoplasm differentiated into muscle and nerve. Muscles, again, are divided into involuntary and voluntary; nerves into nerve endings, nerve trunks, and nerve centres, and these again are sensory and motor. We may again divide nerve centres in various ways into the spinal, the cerebral, and the medullary, and in the medulla again we have got three very marked centres, viz., those for the respiration, those for the heart, and those for the vessels. Some of our drugs seem to have a most marked tendency not to affect protoplasm in general, but to fix most distinctly upon some part of this differentiated protoplasm. For example, belladonna has but very little action upon muscle, and not very much, if any, upon glandular tissue. But it has a very marked tendency to fix upon the peripheral ends of certain nerves, and especially upon those which go to involuntary muscular fibres and glands, paralysing them, and thus abolishing the action of involuntary muscles and stopping the secretion of glands. Other drugs, again, such as chloroform, are complete protoplasmic poisons in large quantities; they will coagulate albumin, they will destroy low organisms, they will destroy the action of the nervous system, and if you inject a little chloroform into the artery of any animal, the whole limb will become as hard as a board, and just as stiff and helpless. Yet that same drug, when taken in smaller quantities, has a particularly selective action upon the nerve centres, and it affects the cerebrum and abolishes pain while heart-beats and respiration, reflex action, and muscular contraction are still preserved.

From this we learn that we cannot always judge of the action of a drug from its action when administered in large quantities. The effect produced by a drug depends, to a great extent, upon the dose of the drug and the tissue which it selects for its first attack.

DOSE.—Now the dose of the drug may be said to be the amount which comes actually into action, and it depends upon very many causes. First of all upon the amount used, as in the case of chloroform; then, secondly, upon the amount which gets into the body in a given time. One of the best examples of the modification in the action of the drug by the amount which gets into the body in a given time is, I think, afforded by the action of the arrow-poison curara. When this is injected under the skin or into the blood it is carried by the circulation to the ends of the motor nerves, and these are paralysed by it, so that the animal or the person who is thus wounded falls down and simply becomes perfectly motionless and dies; but if swallowed by the mouth this poison has little or no action. It sometimes may have an action if taken in enormous quantities on an empty stomach, but, as a rule, it has little or no action. The reason of this is that the poison is so slowly absorbed from the stomach that it is excreted by the kidneys as quickly as it is taken in, so there is never enough of the poison present in the body at any one time to produce an effect. But if we quicken absorption by giving it in very large quantities on an empty stomach, we may possibly get some effect, though not very great. On the other hand, however, if we stop excretion by extirpation of the kidneys or ligature of the renal arteries the animal is poisoned by giving curara by the stomach, just as certainly as if it had been introduced directly into a vein.

When poisoning is produced by stopping excretion in this way, not only do the symptoms usually come on more slowly than after injection of the poison into a vein, but they may actually differ in kind, for convulsions occur which are always absent when the poison is injected under the skin. There is no real difference in the mode of action of the poison in the two cases, and yet there is this distinct difference in the symptoms produced. The reason of this is to be found in the different rate at which the different parts of the organism are affected in the two cases. When you inject curara under the skin, the motor nerves of the muscles are paralysed very quickly, so quickly that they will no longer respond to any stimulus sent to them from the nerve centres. When curara is injected into the stomach and the renal artery or the ureter is tied, the poison, as it becomes absorbed, tends to paralyse the motor nerves going to the respiratory muscles before it paralyses those which supply the limbs. The respiration consequently fails first, and the blood becomes more and more venous. The venous blood acts as a stimulus to the motor centres in the brain and in the medulla, and brings on convulsive movements; the nerves of the muscles being at this time only partially paralysed, so that they are capable of answering to the stimulus sent down to them from the nervous centres. Therefore, we see that a poison may produce different symptoms when given in different ways, although the *modus operandi* is the same in both. In both cases paralysis of the motor nerves is produced, but in one case the nerves of the respiratory muscles are paralysed before those of the limbs, and in the other case the nerves of the limbs are paralysed before those of the respiratory muscles.

Circumstances Modifying the Action of Drugs.—The condition in which a drug is given has a great deal to do with the rapidity of its action. If a poison or a drug be given in a solid form, it is obvious that it must be dissolved before it can pass into the circulation, and if the drug be in a very hard, insoluble form, it may not be absorbed at all. Thus, it happens that sometimes pills are kept by patients for a very long time; they become dry and hard, and when taken by the patient pass out almost unchanged. I once saw some bodies occur in the fæces passed by a patient which were a great puzzle to the doctor in attendance, and it was only by a careful examination that he discovered them to be pills of extract of logwood which had been given no less than three months before to the patient for diarrhœa. The pills had apparently sojourned in the intestine all that time, and you can readily understand that the action which one expected them to produce was completely wanting.

Methods of Administering Drugs.—The quickest way of getting drugs introduced into the system is to inject them either into the veins or subcutaneously. As a rule, one does not inject drugs directly into the blood-vessels except in very urgent circumstances. For instance, in cases of cholera, or the draining away of blood by hæmorrhage, we may inject directly into the blood quantities of saline solution to replace the serum which has drained away either through the bowel in cholera, or the blood which has passed out of the vessels in cases of hæmorrhage. The transfusion of blood has also been used to supply the blood which has been lost by hæmorrhage, and at one time the transfusion of blood from animals was a great deal employed, but this was not found satisfactory, and was soon abandoned. In the present day one very rarely, if ever, transfuses blood from animals, but sometimes one does transfuse blood from one individual to another, the vein being opened in a healthy person and the blood transfused by means of a cannula and an india-rubber tube into the vein of the second person. Sometimes the blood is defibrinated before it is injected into the second person, but more usually now the connection is made directly between the two veins. In order to prevent coagulation during the transit from the one vein to the other various means have been adopted, and perhaps one of the best is simply to have the tube thoroughly washed out with a solution of sulphate of magnesia, but this should not be allowed to flow in any large quantity into the vein of the second individual, because sulphate of magnesia is a powerful poison when introduced directly into the circulation, although it is not at all a poison when introduced in ordinary doses into the intestinal canal.

We sometimes introduce fluid in large quantity into the subcutaneous tissue. For example, in the use of antitoxin, which has now become so common, considerable quantities are injected into the subcutaneous cellular tissue. As a rule, we use this means of introduction more for small quantities of powerful drugs, not more than 10 minims, but in the case of antitoxin, 10 c.c. are often used, and in some instances much larger quantities. Large quantities also of saline solutions have been employed in this manner for the purpose of diluting the blood and tending to wash various poisons that might be present in it out through the kidneys. Absorption takes place generally very rapidly also from the serous cavities, and sometimes saline solution has been introduced into the abdominal cavity for the purposes I have already mentioned.

A good deal of discussion has arisen as to whether absorption takes place from the unbroken skin. Now, the absorption of watery liquids, or of substances dissolved in water, occurs very slowly, if at all, from the unbroken skin; but there can be no doubt whatever that absorption of fatty substances, or substances that will mix with fat, does take place. For example, it was formerly said that absorption would occur from baths, and the instance was given of iodide of potassium which had been dissolved in a bath, and had been afterwards found in the urine, although it was quite certain that the patient had not taken in any of the iodide of potassium dissolved in the water through any of the mucous membranes. On further investigation, however, it was found that in this case the patient had not been completely washed with pure water and then dried after the iodide of potassium bath, and it was stated, probably rightly, that the iodide of potassium had dried on the skin, that the sebaceous secretion from the skin had formed an ointment with it, and that this had afterwards been absorbed. There is no doubt whatever that you can get mercury absorbed in very considerable quantity through the skin, and one of the old-fashioned ways of administering mercury was by inunction. In going through the wards at Vienna many years ago, one saw men sitting by half-dozens saddle-wise on a bench, each man rubbing mercurial ointment on the back of the man sitting in front of him, and in this way mercurial action was rapidly induced.

LECTURE 2.

Administration and dosage of drugs—Absorption—Course of drugs after absorption—Elimination—Excretion and re-absorption—Cumulative action of drugs—Action of a drug depends upon dose—Age-dosage tables.

Gentlemen,

Inunction.—At the end of my last lecture I mentioned to you that absorption may under certain circumstances occur through the skin: that although substances in solution in water are very sparingly absorbed, if at all, by the unbroken skin, yet when mixed with fats they may be fairly readily absorbed. I also said that this method of mixing drugs with fat and rubbing them into the skin is frequently employed for the production of so-called mercurial action, the mercury being absorbed through the unbroken skin. We very often employ this method in the case of children suffering from syphilis, the way in which the mercury is applied being on a flannel binder. Ordinarily a small piece of mercurial ointment about the size of a hazel nut, or even smaller, is simply rubbed upon the flannel bandage, which, being then put upon the child's abdomen, remains in contact with the skin throughout the day. In this way the mercury is absorbed, and the child is affected by the remedy. This plan of applying certain medicines to the unbroken skin is known as the epidermic method.

Endermic Method.—The epidermis, however, presents a very considerable resistance to the passage of anything through it, and another method that is sometimes employed consists in raising the epidermis by means of a blister, snipping off the epidermis, and then dusting upon the dermis, which is thus laid bare, the drug we wish to have absorbed. This method is chiefly employed for the administration of morphine. In cases of neuralgia or severe pain a small blister is applied over the painful point, and the epidermis being snipped off, the morphine is dusted over the skin. We are thus supposed to get not only the general action of the morphine upon the body, but a local sedative action upon the painful part. Doubtless this plan is frequently of very considerable service, and it is one that it is worth while to bear in mind, because every now and again you will be called upon to treat patients with severe neuralgia, and sometimes you will be almost at your wits' end to know what to do for them.

Hypodermic Method.—A more satisfactory method still is that known as the hypodermic method, in which the drug is dissolved and injected into the subcutaneous cellular tissue. There is one caution to be observed in doing this, and that is, you should not inject the drug into a vein. Only the other day one read in the newspapers of a very painful occurrence. A German professor had treated his own child with antitoxin, and the child died suddenly. One does not know the exact reason why the child died, but in this hospital we know that we treat a very large number of children with antitoxin, and they do not die; and that antitoxin, even if it were a poison, is not likely to produce death suddenly if it be injected in the proper way, so that it is not improbable that, unless the child died from what is termed "shock," the antitoxin must have got somehow or another directly into a vein and been transmitted directly to the heart.

Inhalation.—Another way in which medicines are employed, and in which they are quickly absorbed, is by inhalation or by administration in the form of spray.

Occasionally we inject drugs directly into the trachea, but this is of rare occurrence, except in cases where we wish to get direct local action. In some cases of very chronic bronchitis or of phthisis, we may inject some oil, medicated by various drugs, directly into the trachea, and the results of this are sometimes exceedingly good.

Drugs are very rapidly absorbed indeed from the respiratory tract, and the method of inhalation is more especially used in the cases of very volatile substances, such as ether and chloroform, more particularly when we desire to give these for the production of anæsthesia. We employ inhalation also in the case of volatile substances which have other actions than an anæsthetic one, as, for example, nitrite of amyl.

Administration by the Rectum.—Occasionally, instead of introducing the substance into the stomach, we introduce it into the rectum, and there we get absorption occurring fairly rapidly, but not so rapidly as through the stomach and intestines. In consequence of this, there is a general rule that when you are giving opium by the rectum you may just double the amount of the drug which you would employ if you were giving it by the stomach. If you are going to give, for example, 15 minims of tincture of opium as a dose by the stomach, you would give 30 minims if injected into the rectum. The rectum affords a convenient way of administering drugs when they cannot be retained by the stomach; when, for instance, the patient is suffering from vomiting, and every drug which is taken by the mouth is at once brought up. The rectum affords also a means of introducing nutriment. When one desires to give a drug which is to act locally upon the rectum, and is not to be returned, a small quantity of vehicle is used; because, if a large quantity be employed, the rectum is excited to contraction and defæcation is brought about, with evacuation of the substance which has been introduced. The quantity used should be 2 fluid ounces, which is just an ordinary sherry-glassful, and is not enough to distend the rectum. If we wish to give any drug which is intended to be evacuated, for example, soap and water, or castor oil, we use a larger quantity of the vehicle, say, 16 fluid ounces, because this distends the rectum and evacuation is induced. In cases where an intermediate effect is desired, for example where you want to get wind evacuated, you choose a quantity between the two. In the case of asafœtida injection, where you wish to bring away a quantity of flatus from the rectum, 4 fluid ounces are used. Sometimes, however, even a small quantity of liquid is not easily retained, and we may then employ a convenient method of introducing drugs in combination with a soft fat, the fat which is used being "cacao" butter. This is hard at the temperature of the external air, but melts readily when introduced into the rectum. The butter then forms a smooth coating over the rectal surface, the drug which it contains is applied over the mucous membrane, and is gradually absorbed without exciting much tendency to evacuation.

Mouth.—The usual channel for the administration of drugs, however, is the mouth, and we give drugs by the mouth in many ways, as powders, pills, or draughts. Now, you can readily understand that the rapidity with which our drug will act will depend very much upon the physical condition in which it is introduced. One knows the old proverb, "There's many a slip 'twixt the cup and the lip;" and if the person does not get the cup to his lip his thirst will not be satisfied, although there be abundance of water in the cup. Nor will his thirst be satisfied if he gets a lump of ice into his mouth, provided the ice does not melt. You know that travellers in the Arctic regions are often troubled by a frightful thirst, and they are tempted, in the absence of water, to fill their mouth with snow; but the low temperature of the air and the mass of snow they put into the mouth keeps it from melting, and after a while it feels just like a bit of red-hot iron. It is only when the snow becomes converted into water that the thirst will be quenched. A solid will not quench thirst, and neither will drugs have any action upon the body so long as they remain in an undissolved condition. Sometimes we dissolve our drugs before giving them; at other times we trust to their being dissolved in the intestinal canal, either by the liquids dissolving them physically or by the gastric or intestinal juices dissolving them as chemical agents. For example, we frequently give quinine in solution, but in the tropics it is very often the habit to have quinine standing in powder upon the sideboard, and each person helps himself with a teaspoon. Quinine is easily taken thus in the solid state, because one does not taste its intense bitterness; but a great part of the quinine taken thus in such large quantity goes to waste, because there is not sufficient acid in the gastric juice to dissolve the whole of it. This is more especially the case when the quinine is taken by a person who is suffering from fever, because in fever, as a rule, the secretion of hydrochloric acid in the stomach is either very much lessened or is entirely arrested. Thus you will hear many persons who have been living in the tropics tell you that they have taken quinine by the teaspoonful, and they will very likely laugh at you if you order them 5 grains in solution. But you must remember that your 5 grains in solution may have more effect than the teaspoonful which they took without any acid.

So long as drugs simply remain in the intestinal canal, either in solution or in solid form, they have only a local action upon the intestinal tube. This local action may be distinct enough. If, for example, we give a quantity of mustard suspended in water, there will be a distinct action upon the stomach, and well-marked vomiting will probably result, though none of the mustard may have been absorbed into the circulation. In the same way, we may have a quantity of castor oil taken into the stomach; it will pass out through the intestinal tube, causing local irritation of the intestine, movements of the intestine, and free purgation, yet none of the castor oil may be absorbed. Until our drugs have been absorbed into the circulation, they are as much outside the body as if they were simply held in the palm of the hand; the only difference being that the palm of

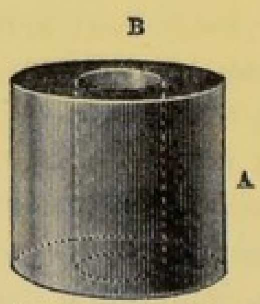

FIG. 2.—Diagrammatic representation of the body. A is a box to represent the tissues; B is an inner tube to represent the intestinal canal. It is obvious that anything which is merely in the inner tube is outside the box, and, similarly, anything which is merely in the intestinal canal is outside the body.

the hand is less sensitive to local action, and is more resistent to absorption. The only action a drug remaining in the intestinal canal can have is what it can exert reflexly through the nerves passing from the stomach and intestine.

CONDITIONS FOR ABSORPTION.—Now, absorption depends not only upon the physical or chemical character of the drug, but upon the conditions which it meets with in the intestinal canal. If we put a soluble drug into an empty stomach, the chances are that it will be absorbed a good deal more quickly than if we put it into a full stomach, and this is well known, not only to medical men, but to the public in general.

If a man drinks a large glass of whisky upon an empty stomach, he is very much more likely to be intoxicated than if he drank it after a meal. You can readily understand why. In the case of the empty stomach, the alcoholic liquid comes in contact with every part of the mucous membrane, and will thus be readily absorbed; but if the stomach be full the whisky will become mixed with, and fairly well diffused through, the contents of the stomach. It must take its chance of absorption with the rest of the gastric contents, and is not likely to pass into the circulation until a considerable quantity of the gastric contents has been absorbed with it. On account of this, when we use drugs which might have a strong local action upon the stomach which we wish to avoid, we direct them to be taken immediately after meals. Thus it is a rule, if one is giving arsenic, in order to produce its action upon the nervous system, or upon the nutrition generally, to order the drug to be taken immediately after meals. The arsenic thus becomes mixed with the food, local action upon the gastric mucous membrane is avoided, and any injurious local consequences prevented, though if a full dose of arsenic were given upon an empty stomach, it would probably be found that after several doses had been given the patient would begin to complain of pain in the epigastrium, and very likely of sickness and vomiting. On the other hand, if you wish to give this drug in order to obtain its local action upon the stomach and intestines, you direct that it should be taken before meals, on an empty stomach; and this you occasionally do in order to check a particular form of diarrhœa, where the patient complains that no sooner has he sat down at table and commenced to eat than he is obliged to rise up and rush to the water-closet. In such cases one of the best remedies is arsenic before meals, say, a dose of half a drop or one drop of the liquor arsenicalis.

You may find also that there are conditions of the stomach, brought about by the local action of a drug, which prevent its own absorption. For example, if some tartar emetic or ipecacuanha be given, it will produce vomiting through its local action, and very likely tend to prevent any absorption. In cases where you have an irritant substance, such as turpentine, the curious result is often found that a big dose may be given with safety, while a small dose may be dangerous. Half an ounce or an ounce of oil of turpentine may generally be administered without the slightest risk, but 2 drachms or even 1 drachm may cause most severe inflammation of the kidneys. At first sight, it seems very odd that the small dose should be dangerous, and the large one harmless, but the reason of this is simply that the large dose stimulates the stomach and intestines, and, acting as a purgative, causes the oil of turpentine to be swept out of the intestinal canal before any opportunity has been afforded for its absorption. When a small dose is given, this local action is not exerted to the same extent; the drug remains a long time in the intestine and is finally absorbed, passing out through the kidneys, and in the course of its elimination through them gives rise to congestion of these organs.

Besides this, we find conditions of the stomach which alter the absorption of drugs, but which depend not upon the local action of a drug taken into the intestinal canal, but upon other conditions, such as those of the nervous system.

You will, in the course of your work as medical men, frequently meet with patients who suffer from sick headache, and they will tell you that your drugs relieve them if taken before the headache comes on, but are useless if the headache has once fairly begun. The reason of this is simple enough. During a sick headache, absorption from the stomach seems to be at a standstill, and if a patient has taken a meal just before or during the attack, you will probably find that hours afterwards the meal is vomited, so that these headaches have got the name of sick or bilious headaches. What happens to the food happens also to medicines, and if antipyrin or phenacetin, or some of the other well-known remedies, be given for a sick headache after it has fairly begun, they might just as well be thrown into the sink. There is no absorption taking place, and so no good effect results upon the headache, and sometimes, if patients are not told that this is the case, they will throw their medicines away. They not only lose confidence in the medicine, but they lose confidence in the doctor who prescribed it and leave him in disgust, and you meet them by chance perhaps two or three years afterwards, and they say: "I took your medicine, and it acted like a charm the first time, but the second time it had no effect at all, and I did not take any more;" the reason being that the first time they had taken it before the headache had attained such a height as to stop absorption from the stomach, the second time they were too long in taking it, absorption had been arrested, and the medicine had not a chance of acting.

We find also, in cases where absorption from the intestinal canal has been arrested by disease, the drugs may remain a considerable time without being absorbed, and afterwards undergo absorption. In some of the epidemics of cholera it was found that after the so-called "algid" state had passed away the patient recovered from the disease, but died of the morphine that had been given to him previously in order to check the diarrhœa. The morphine or opium lay in the intestinal canal unabsorbed so long as the patient was in a condition of collapse, but when he recovered from the disease, and his circulation became re-established, absorption recommenced, the opium was taken into the circulation, and the man died of opium poisoning.

After absorption has taken place through the intestinal walls, or otherwise, into the blood, the drug which has been absorbed will meet with the various constituents of the blood, and will probably partially enter into combination with them. Some drugs, such as metals, probably become combined with the albuminous constituents of the blood; others of them, such as alkaloids, probably remain simply absorbed in the serum.

There is one organ with which we always have to reckon in cases where we give a drug by the stomach or intestines, and that is the liver. For you must remember that before any drug or any food which is absorbed from the stomach or intestines can pass into the general circulation, it must go through the liver, and the liver has the property of not only turning back foods or drugs that are likely to prove injurious to the body, but sometimes of actually destroying them. Many poisons when injected into the stomach or intestines are absorbed by the blood-vessels, carried to the liver, and are excreted by that organ; they are poured with the bile into the duodenum, and thence are again absorbed. So that certain poisons may go on and on in a regular round from the stomach and intestines to the liver, from the liver to the intestine and back again, for days, probably weeks and even months, without ever getting into the general circulation. Probably this is

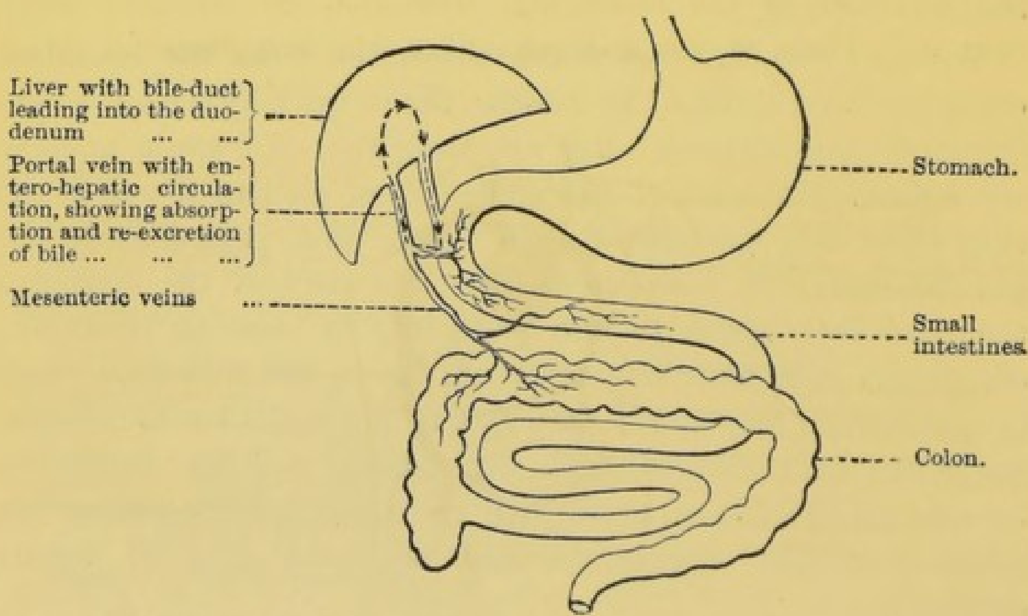

FIG. 3.—Entero-hepatic Circulation.

the reason why we find occasionally that bile is so bitter. Bile when freshly secreted, as it is found in cases of biliary fistula, where it flows directly from the liver as quickly as it is formed, has no bitter taste at all, but when vomited, as it frequently is in persons who have been suffering from so-called biliousness, it often has a very bitter taste. I do not think that the exact nature of this bitter taste has ever been investigated, but we know that when albuminous substances are somewhat over-peptonised a bitter substance is formed, and probably it is this which gradually accumulates in the liver, and gives to the bile its intensely bitter taste.

COURSE OF DRUGS AFTER ABSORPTION.—After the drugs have passed through the liver they are carried first of all to the right side of the heart, thence on to the lungs, and there many volatile substances may be eliminated. For example, sulphites or sulphuretted hydrogen injected into the rectum are taken up from it by the blood-vessels, carried through the liver into the right ventricle of the heart, and then through the lungs, where the sulphuretted hydrogen is so rapidly eliminated that no poisonous action is usually produced, although if injected directly into the arterial system it would prove a fatal poison.

From the lungs the blood and the drugs it contains get into the left side of the heart, and from that on into the aorta (Fig. 4). Then, as you will remember, the first branches given

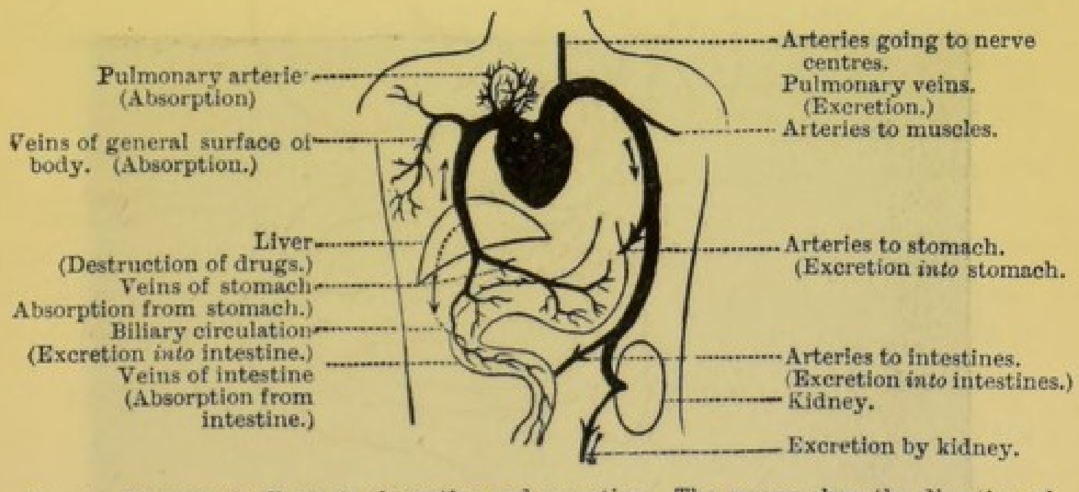

FIG. 4.—Diagram to illustrate absorption and excretion. The arrows show the direction of the currents. The absorbents from which the blood passes directly into the general circulation are represented diagrammatically by the veins of the lungs and of the general body surface in the figure; the absorbents by which the drug must pass through the liver, and possibly be partly excreted or destroyed, are represented by the veins of the stomach and intestine; the excreting channels by which the drug may pass directly from the body without re-absorption occurring are represented by the vessels of the lung and by the ureter; those by which excretion takes place into cavities from which much re-absorption may occur are represented by the arteries to the intestine and the stomach.

off by the aorta are the coronary arteries, which go to the heart itself; so that the heart itself is one of the first organs to receive any drug which is passed into the circulation, and, therefore, if that drug have any action, the heart will be one of the first organs affected thereby. Consequently the supply of the drug to the other organs may be affected. But not only does the blood and the drug it contains go to the heart: it is carried to the nervous system generally, including the brain, the medulla, with all the centres it contains, the spinal cord, the nerve fibres, and nerve terminations. It passes to the muscles, both voluntary and involuntary, and to the various secreting glands, and it is taken up by them and passes into their secretions.

ELIMINATION.—Some of these secretions are poured out into the interior of the body; others are poured out externally. When the drug passes into those that are thrown out externally, as into the urine or into the sweat or into tears, then it is eliminated through the kidneys, sweat glands, or lachrymal glands.

In other cases it may be poured back again into the intestinal canal, and a good example of this is iodide of potassium. Iodide of potassium when absorbed from the intestine passes

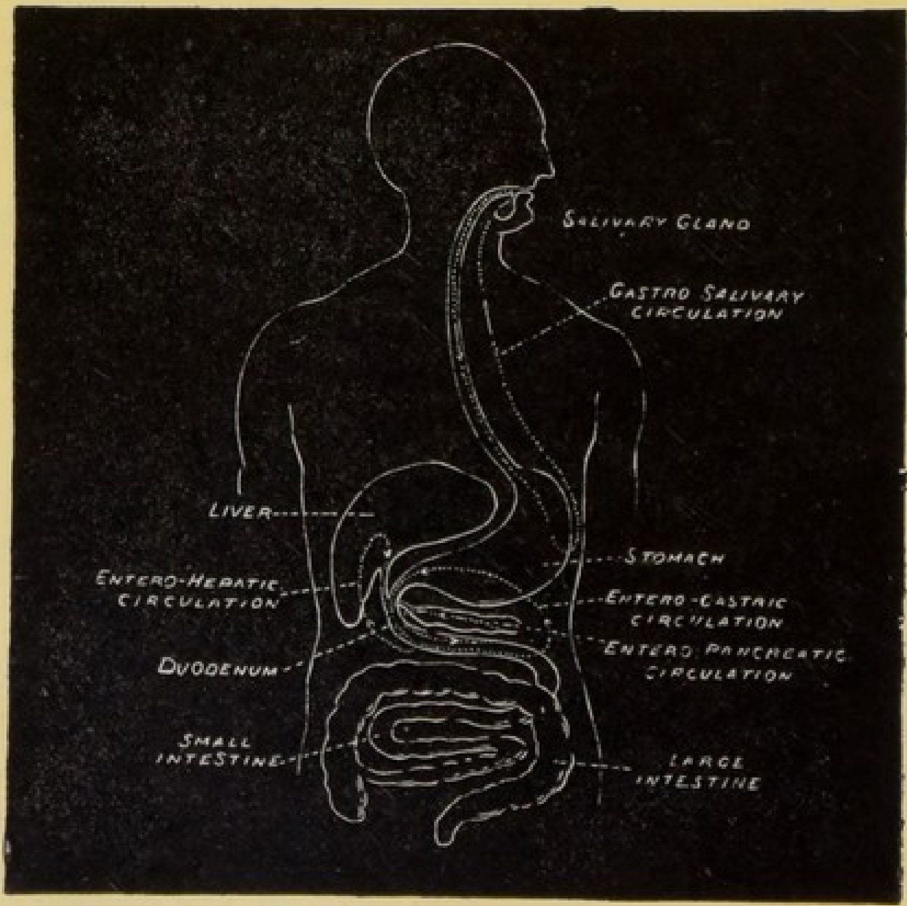

FIG. 5.—Gastro-salivary—Entero-gastric—Entero-hepatic—Entero-pancreatic circulation.

into the sweat and into the urine. It also passes very readily into the saliva, and the saliva, being poured into the mouth, is swallowed, so that the iodide of potassium goes on in a continual round from the salivary glands into the mouth, and then into the stomach; from the stomach it is re-absorbed, and goes back into the salivary glands, and so on. This going round in a circle is similar to what happens with many drugs in the case of the liver, as I mentioned above. In this way, although iodide of potassium is rapidly excreted through the kidneys, some of it may be retained for a long time in the body without being eliminated.

This retention may be still greater with certain other substances, which are not poured out readily through such watery secretions as the saliva, but which pass out through the mucus of the intestinal canal or of the stomach (*vide* Fig. 4). Now, both the stomach and the intestine are excreting organs, and when poisons, such as tartar emetic, are injected into the circulation or under the skin, they are carried by the blood to the stomach and intestine and excreted; so that after the injection of tartar emetic into the blood, if the animal be killed and the mucus scraped from the stomach, tartar emetic will be found in the mucus of the stomach. The same is the case with cobra poison injected under the skin. It is eliminated by the mucous membrane of the stomach; and poisons of a similar character, such as the tox-albumins of cholera, are also eliminated by the stomach. Lead is probably eliminated partially by the mucous membrane of the stomach, but it is eliminated to a greater extent by the mucous membrane of the intestinal tube, so that in cases of chronic lead poisoning one finds a quantity of lead in the mucus of the intestine.

You can readily see that, while substances are being eliminated at one time, they may be absorbed at another; for while the cobra poison, or any substance of a similar nature, may be eliminated by the mucous membrane of the stomach, the mucus after it has left the stomach may pass on into the intestine, and there undergo re-absorption, and so it is very difficult in some cases to clear the organism completely of a poison that has been once introduced.

Excretion and Re-absorption.—This is a subject of which we are only beginning to know something. Very little is known at present about the poisons which are formed in the organism itself, of their excretion, and of their re-absorption. In all probability, however, such excretion and re-absorption goes on to a considerable extent, just as in the case of the normal digestive juices, which, as you will find in your books on physiology, are secreted in very large quantity and are re-absorbed. There is, however, one practical observation which probably is based upon something of this sort, although not wittingly. You know that people frequently get into a state of discomfort, or malaise, when they do not know very well what is the matter with them. They have no very distinct complaint to make, but they are not well. You inquire about the state of their bowels, and you find that they are going on perfectly regularly, and there seems to be no reason whatever why you should interfere with the intestinal tube, but you find that if you give those people a brisk purgative they are very much the better for it. The purgative seems as if it cleared away something which was at the bottom of their malaise. Now-a-days we do not often use emetics for this purpose, but in days gone by emetics were freely used, and were probably used to great advantage, although the abuse of emetics, like the abuse of blood-letting, has now led to a disregard of them which is probably too great. It is quite likely that if one were to use them more frequently one would get more good results from them than at present.

Now, the amount of any drug circulating in the body at a given time depends upon the ratio of its absorption to its elimination. I will try to show you by a simple experiment that if you increase the rapidity of absorption and lessen the rapidity of elimination, you get the substances accumulating very rapidly. Let us take two funnels, each provided with a stopcock. The upper funnel may represent the stomach, and its stopcock the vessels through which absorption occurs; the lower funnel may represent the body generally, and its stopcock the channels of elimination, the chief channel of elimination being always the kidneys. If we close the stopcock of the

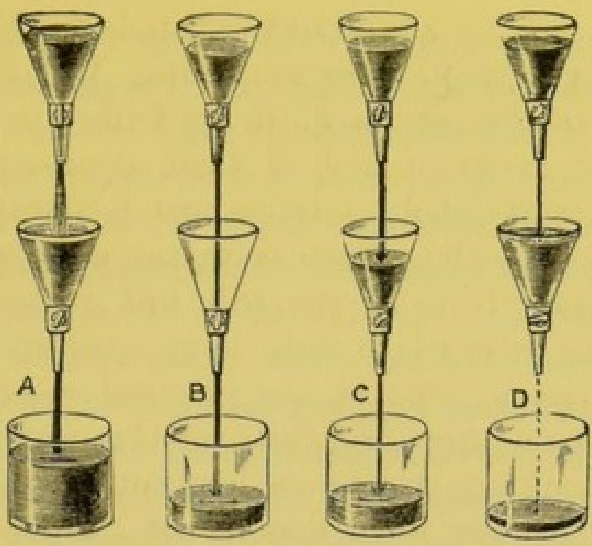

FIG. 6.—Diagram to illustrate the differences produced in the amount of a drug present in the organism by alterations in the rate of absorption and excretion. The lower funnel represents the organism. A represents the condition when a drug is rapidly introduced, as by injection into a vein. In this case the drug, *e.g.*, curara, comes to be present in large quantities in the organism, and produces its full physiological effect. This is represented by the fulness of the lower funnel. And it does this notwithstanding the rapidity of excretion, which causes the drug to be quickly eliminated and to appear copiously in the urine, as represented by the fulness of the beaker into which the fluid flows from the lower funnel. B represents the condition when a drug is slowly absorbed and rapidly excreted, as when curara is given by the stomach. In this case the quantity present in the blood at any one time is very minute, as represented by the empty condition of the lower funnel. C represents the condition when absorption is rather quicker than excretion, as when a dose of morphine is given by the stomach. D represents the condition where absorption is moderate, but excretion is interfered with, leading to accumulation in the blood, as where an active drug is given by the mouth, and the kidneys are much degenerated.

upper funnel, no fluid gets into the second, however full the first may be, so you see that unless we get a passage for our drug from the stomach into the body it remains outside the body; if we slightly open the first stopcock whilst the second remains closed, the second funnel gradually becomes full, so you see that if elimination is entirely prevented a drug will gradually accumulate in the body, even though absorption be slow, until at last a large quantity is present; but if we open the second stopcock as well as the first, the funnel representing the body remains empty, so you see that if elimination goes on at the same time and at the same rate as absorption no accumulation occurs: only a little gets into the body and circulates there, but it does not increase.

Cumulative Action.—There are certain drugs which are termed "cumulative," because, after they have been administered for a certain length of time, they suddenly give rise to well-marked symptoms. Thus, after digitalis has been given for some time, you may find that suddenly one morning the pulse has become very slow or intermittent, and the patient is beginning to complain of sickness, although you have not increased the dose of the drug. The reason of this appears to be that when the digitalis has attained a certain power over the body it stops its own elimination by contracting the renal vessels, so that after a while the secretion of urine, which had at first been copious, becomes scantier, and the other organs of the body become affected. In the same way, strychnine, after being given for a time, appears to cause a sudden increase in the reflex excitability of the body, an increase which is not explained by any increase in the quantity that you have given. The reason in this case also seems to be that after it has been administered for some time it stops its own elimination.

There is another reason which has been given for this so-called cumulative action in some cases, and especially in that of digitalis. It has been said that digitalin is so insoluble that it sometimes will lie a long time in the intestine without being absorbed, and that then, for some reason or another, it becomes absorbed, and a sudden increase in the symptoms results.

I think, however, that this explanation does not hold good in the case of the soluble preparations of digitalis which we in this country usually employ. This same reason has been advanced also in explanation of the cumulative action of strychnine, and it has been said that this drug given in the form of the alkaloid itself is much more liable to produce cumulative effects than if it is given in the form of a soluble salt, such as the sulphate or hydrochlorate. I believe in both cases the most feasible explanation is that the drug stops its own elimination by acting upon the kidneys.

As I have already said, the real dose which acts upon the body is the difference between the amount taken into and the amount passing out of the body in a given time.

Effect of Dosage.—A small dose may have an entirely different effect from that of a large dose. For example, a very small dose of atropine may slow the pulse, a very large dose may quicken it and will quicken it, and an enormous dose may slow it again, but the effect of the drug in these three cases is different. The first slowing of the pulse is due to stimulation, probably of the vagus roots, and the second quickening to paralysis of the vagus ends in the heart, while the third slowing is due to weakening of the cardiac ganglia. But a very general rule is that, while small quantities of almost anything may stimulate, large quantities will paralyse, and this holds for food, for exercise, for mechanical stimuli, and for drugs. If a man has a moderate meal, he will become more active, but if he overeats himself, he may lie sleepy and drowsy like a boa-constrictor and hardly move from his chair. In the same way a small quantity of alcohol may stimulate to increased mental activity or bodily activity; a large quantity will simply make the man an inert mass. A stroke from a switch will quicken any animal to increased exertion, but a blow from a bludgeon may knock it down and render it incapable of any exertion at all. So that, as a general rule, you may say that if a drug in very full doses has any effect, quite small doses will have a different effect, very often the opposite. Of course this does not hold completely, because, as I have just mentioned in the case of atropine, a very small dose will slow the heart, a moderate one will quicken it, and a still larger one will again slow it; so that we have three different effects to choose from, and you cannot formulate this as a rule of practice.

Homœopathy.—But it has been formulated by Hahnemann—and the rule is known in homœopathic parlance as *similia similibus curantur.* If any drug produce symptoms similar to those of a disease, that disease, said Hahnemann, will be cured by that particular drug if administered in doses smaller than those that would produce the symptoms of the disease. You see, however, that practically this rule comes to the same as *contraria contrariis curantur*, and that he was simply in administering the smaller doses giving drugs which produced an opposite effect to those caused by the disease, because the drugs in different doses produced different and contrary actions. For example, the administration of small doses of atropine as a remedy in cases of abnormally rapid pulse may be regarded as homœopathic treatment, because large doses of atropine cause great rapidity of the pulse, a symptom like that which we wish to combat. But it may also be looked upon as antipathic treatment, for minute doses of atropine produce slowing of the pulse, a symptom which is the opposite of that which we wish to combat.

The great objection to homœopathy is that it gives you as a rule to be universally trusted a rule which is false, and which will not hold in every case. The best way of convincing oneself of the insufficiency of any such rule as this is to take one of the largest homœopathic text-books and look through it. When I was a student I thought homœopaths were badly treated. I was rather fond of working at materia medica; I read a good deal about it, and thought that, as many drugs did actually cause in larger doses different effects from what they produced in smaller ones, there might be a good deal of truth in the homœopathic doctrines. At one time I proposed to read a paper before a students' society in defence of homœopathy, and if I had only read the books that abused homœopathy I have no doubt I should have read the paper. But, unfortunately for my purpose, I began to read up some homœopathic text-books, and one of the things I came across was this:—" Treatment of a stillborn child. Take a small bottle of" some particular tincture—I forget the name—" and put five drops of the tincture into a glass of water, and put five drops of this mixture upon the tongue of the child every five minutes until it recovers." Well, I thought probably one might go on *ad infinitum* doing this, and so I stopped writing my defence of homœopathy. If you wish to convince yourself of the defects of homœopathy, I recommend you to read Dudgeon's " Cyclopædia," in which you will find pages and pages and pages devoted to a description of the symptoms produced by aconite. You will there see that it simply produces all the symptoms under the sun, and that you can choose it for any disease or for any group of symptoms, and you can also use it for the opposite group of symptoms, because it not only produces one set of symptoms, but also their exact opposite.

The curious thing about it is that homœopathy was founded upon observed facts erroneously interpreted. The way it came about was this. Hahnemann suffered from ague at one time.

He had not had an attack for some years, but one day he thought he would prove the effect of cinchona bark upon himself. He took a whole tablespoonful of cinchona bark. Other people have taken a tablespoonful of cinchona bark and found it act as a very active irritant to the stomach, causing violent vomiting. Hahnemann apparently did not vomit, but he got a violent rigor and a well-marked ague fit. This return of ague after it has been absent for some time is a thing that is well known to every one who has had to do with the disease. An ague fit in many patients may be brought on by any strong irritation, and if Hahnemann had taken mustard and water or anything else equally irritant the result would very likely have been the same. But having taken cinchona, he said, "Cinchona is a remedy for ague, and in me it has brought on the disease; therefore cinchona being the remedy, and having brought on the disease, a small dose of a drug which produces certain symptoms will cure the same symptoms when they are caused by disease."

He next went on to develop the homœopathic doctrine in the form of giving not only smaller doses, but further preached reduction and reduction until the dose was reduced almost *ad infinitum*. In favour of this he brought forward the fact that if a small quantity of mercury be triturated for a length of time it becomes more and more powerful. He had not taken into consideration the fact that if you triturate mercury for a long time you alter it, and you produce instead of the mercury a mercurous and afterwards a mercuric oxide; so that upon those two errors he founded the whole of his system.

Duration of Action.—You can readily see that the *duration* of the action of a drug will depend very much upon the rapidity of elimination; if it is slowly eliminated it will go on acting for a long time, especially if it is one of those drugs which circulate from the duodenum to the liver and from the salivary glands to the stomach.

Rules for Dosage.—The *amount* of action produced by a drug will vary very much according to the size of the body into which it is put. You can easily understand that if we administer, say, 1 drachm of a tincture to an adult weighing

200 lbs., and give the same quantity to a child weighing 10 lbs., that the proportion of the drug to the child will be 20 times greater than in the adult, and so the same quantity given to both will be a very much larger dose to the child than to the adult. In cases of experimentation upon animals where we wish to compare the amounts of drugs necessary to produce a given effect very precisely, the actual dose as a rule is not stated, but the proportion to the body weight of the animal is given, so that, for example, we say that 1 centigram of a certain drug to a kilogram of animal weight produces a certain effect. For this reason we give as a rule a larger dose of a drug to large men than to small men, and we generally give smaller doses to women, because the bodies of women are as a rule smaller than those of men. In calculating the amount of a drug that you have to give, you do not take into consideration the amount of fat that a man has, because fat is an inert tissue and does not count. It would in fact count against the large dose, and if you had to deal with a large flabby man you would probably be content to give him rather less than you would to a man of the same height and the same breadth of shoulder, but without the same amount of fat. For the tissues of the fat man being as a rule flabby, he would not stand so much of the drug as the healthy man would.

To children you generally give very much less than you would to adults. There is a rule, known as Young's, which is commonly used for ascertaining the fraction of an adult dose which should be given to a child. This is done by taking the age of the child as the numerator of the fraction, and the age with 12 added as the denominator.

Thus, if you want to know how much of a medicine you must give to a child five years old when 60 minims would be the dose for an adult, you take $\frac{5}{5+12} = \frac{5}{17}$ of 60 minims. This dose comes between a third and a fourth, so if it were a big child for its age you would give $\frac{1}{3}$, or 20 minims, and if it were a small child $\frac{1}{4}$, or 15 minims, for a dose.

The decimal system has not yet come into general use in prescribing in this country, but it is sure to come by-and-by, when a rule which I have formulated may be more convenient than Young's. It consists in taking the adult age as 25 and reckoning each year which the child has *commenced* as an even part of 25. Thus for a child which is two years old and has commenced its third year, so that it will be three on its next birthday, the dose would be $\frac{3}{25}$ of the adult dose, for a child three years old $\frac{4}{25}$, for one five years old $\frac{6}{25}$, and so on. The convenience of this plan is the ease with which 25 can be converted into 100 and with which division by 100 can be effected.

Let us take as an example the quantity of quinine you want for a child seven years old. The dose for an adult is, let us say, 5 grains, *i.e.*, rather less than $\frac{1}{3}$, or about 0·33 of a gramme, which is 15·432 grains; the dose for a child aged seven and whose next birthday would be eight is $\frac{0·33 \times 8}{25} = \frac{2·64}{25} =$ 0·1056. That is, we multiply the dose by the age of the child at its next birthday and then divide by 25. But instead of dividing by 25 we can multiply both the numerator and denominator by 4, when the 25 becomes 100: thus $\frac{2·64 \times 4}{25 \times 4} = \frac{10·56}{100}$. But division by 100 is effected by simply shifting the decimal point two places to the left, so that 10·56 divided by 100 becomes 0·1056, which is the dose required. Disregarding the

Age.	Fraction of adult dose at each age.	
	Young's.	Brunton's.
1	$\frac{1}{13} = \frac{2}{26}$	$\frac{2}{25}$
2	$\frac{1}{7} = \frac{3}{21}$	$\frac{3}{25}$
3	$\frac{1}{5} = \frac{4}{20}$	$\frac{4}{25}$
4	$\frac{1}{4} = \frac{5}{20}$	$\frac{5}{25}$
5	$\frac{5}{17}$	$\frac{6}{25}$
6	$\frac{1}{3} = \frac{8}{24}$	$\frac{7}{25}$
7	$\frac{7}{19}$	$\frac{8}{25}$
8	$\frac{2}{5} = \frac{10}{25}$	$\frac{9}{25}$
9	$\frac{3}{7} = \frac{12}{28}$	$\frac{10}{25}$
10	$\frac{5}{11} = \frac{10}{22}$	$\frac{11}{25}$
11	$\frac{11}{23}$	$\frac{12}{25}$
12	$\frac{1}{2} = \frac{12}{24}$	$\frac{13}{25}$

smaller decimals, we have as the dose 0·1 gramme (1 decigramme) which is equal to about $1\frac{1}{2}$ grains.

Young's table and mine correspond fairly closely, and his table is decidedly more convenient for vulgar fractions, but mine would be easier for decimals.

Influence of Age on Dosage.—There are, however, certain differences in the adult and in the child, in regard to their comparative susceptibility, apart from size, and there are some drugs which require to be given with very great care to children; one of these is opium. An exceedingly small dose of opium may sometimes prove fatal to a child. There is one case where a child is said to have been poisoned with 1 minim of tincture of opium. I do not think that this is true, because one day, in looking through some second-hand books in a tray outside a shop, I happened to come across the book containing this story. I did not buy it at the moment, and when I went back next day to buy it found, to my sorrow, that it had been sold in the interval. I have forgotten the name of the book, and must trust to my memory for the story. I think it was that the tincture of opium had been contained in a small phial that was not carefully closed by a cork, but only by a little bit of paper, which had been twisted round. This bottle had been kept on the mantelpiece for some time, and really contained a somewhat concentrated solution of opium, of which one does not know the exact strength, and I have not been able to see the book since. Although this story of the 1 minim may have been exaggerated, there is no doubt whatever that one is obliged to give very much smaller doses of opium to children than to men. On the other hand, children, as a rule, stand belladonna very well, and almost no poisonous result may occur in a child from a dose of belladonna that in proportion would produce in an adult most serious symptoms. Another drug that we may give to children freely is bromide of potassium, and 5 grains of bromide of potassium, which would seem an enormous dose if reckoned out in proportion to the adult, is very often borne perfectly well by children.

LECTURE 3.

Modification of action of drugs—Internal secretion—Venins and antivenins—Toxins and antitoxins.

GENTLEMEN,

There is another time of life when one has to take special precautions in regard to the administration of drugs besides early infancy, and that is in old age, for in old people the processes of life are feeble, and they do not stand the administration of depressing drugs. You must, therefore, be careful about giving violent purgatives to old people, or such medicines as are likely to impair their appetite and prevent their taking the amount of food that is necessary to maintain their strength.

Another condition that obtains in old people is a certain brittleness of the arteries, so that any drug that is likely to make them use more than ordinary exertion, such as, for example, an emetic, is to be given with caution, because the violent efforts of vomiting might cause a vessel to burst and bring about the death of your patient.

Now it is very frequently the business of the medical man to decide between various risks, and it is almost certain that you will have to decide between various risks in the case of old people, because one of the most common causes of death in the aged is bronchitis, and in certain cases, where the secretion from the bronchial tubes is very free, the old man or old woman is in great danger of being stifled by its accumulation in the air-passage. In such cases you may have to administer an emetic, otherwise the chances of your patient's recovery are very small. You must judge between the risk of the patient dying from suffocation and dying from rupture of a vessel; but it is quite probable that by the judicious choice of your emetic, and the regulation of the dose that you give, you may bring about vomiting, with emptying of the secretion from the bronchi, without causing such violent retching as to give rise to the bursting of a vessel.

Menstruation.—There is a temporary condition in which we are also obliged to be careful about the administration of certain drugs, and that is during menstruation. The processes of life in the female during menstruation seem to undergo certain alterations with the nature of which we are imperfectly acquainted; but the ordinary experience is that women during menstruation have a tendency to react in a different way towards medicines between the periods, and the question will be very commonly put to you by your female patients, "Am I to continue with the medicine during the period or not?" In the case of any simple medicines, such as mild purgatives, and mild narcotics, such as bromide of potassium, there is no harm to be feared from the continuance of the drug; but in cases of drugs the action of which is less known it may be very advisable to discontinue their administration. For example, in some cases antipyrin has been given in ordinary doses during menstruation, with the effect of producing great collapse and cyanosis, although the same drug had been given in the same doses to the same person in the intervals between menstruation without producing any bad effect.

Idiosyncrasy.—We find occasionally in individuals a peculiar reaction towards drugs, which is not merely temporary, as it is during menstruation, but is permanent during the whole of the individual's life. This peculiarity may consist either (*a*) in too great reaction towards a drug, or (*b*) in too little reaction towards it, or (*c*) in an altered kind of reaction. Thus a very small quantity of opium, or of a mercurial, may be sufficient to exert an extraordinary effect upon certain individuals. One case is recorded where one-eightieth of a grain of corrosive sublimate was sufficient to bring about salivation in a patient. This is a very extraordinary reaction to a very small amount of a drug. Not unfrequently we find just the opposite effect, so that very large quantities of a purgative, for example, have little or no action upon your patient; and in some cases enormous quantities of opium may be taken by a patient who has not previously been accustomed to take the drug, and yet it produces little or no effect. The third reaction is that of a curious and unusual consequence following the administration of a drug. For instance, in many cases quinine, and allied substances, such as antipyrin and phenacetin, will bring out a marked rash upon the patient's skin, and at the same time may cause intense itching, which almost drives the patient wild. All these three different reactions are examples of the so-called idiosyncrasy, yet some of the results which we find natural in idiosyncrasy may be brought about by habit.

Habit.—I have just mentioned a peculiar resistance to the action of opium which obtains in some people naturally. This resistance may be acquired by almost anyone who begins by taking small doses of opium, and gradually increases them, so that at the last enormous quantities may be taken without almost any effect. I have seen one patient who was in the habit of injecting daily under the skin from 24 to 32 grains of morphine, a dose that would have proved fatal to 30 or 40 ordinary people not accustomed to the use of the drug.

Toleration.—We find in disease a condition which is known as toleration, and which is nearly allied to the effect of habit. A healthy person taking a dose of tartar emetic would become sick, but in inflammation of the lungs very large doses of tartar emetic have been given to patients who had no previous habit of taking the drug, and yet no vomiting was produced; they had acquired what is known as tolerance of the drug. In the same way we find that in cases of peritonitis very large doses of opium are tolerated.

The exact causes of toleration in all cases I do not know. In the case of the tartar emetic, it seems probable that it is partly due to the fact that during febrile disorders very little acid is secreted by the stomach. If you rub tartar emetic upon the skin, you find that it does not cause general inflammation, but causes a pustular inflammation, and the centre of the pustule is the opening of one of the sweat glands, where the tartar emetic meets with an acid secretion by which it appears to be decomposed, forming a more active salt of antimony than the tartrate, and this gives rise to inflammation. In cases where tartar emetic is introduced into a healthy stomach, it probably undergoes a similar decomposition by the gastric juice, and a considerable amount of local irritation is produced, but if the stomach is not secreting hydrochloric acid, the decomposition of the tartrate of antimony and potash does not occur, less irritation is produced, and so a tolerance of the remedy comes about.

Exercise.—We find a similar condition occurring in the case of alcohol. You all know that a man who is walking about the moors all day long is able to take without any harm, possibly with advantage, a quantity of alcohol which is very great when compared to the amount he could support if he were living in town and taking little or no exercise. The explanation of this fact probably is that during active exercise the alcohol undergoes oxidation in the body, and has not the same paralysing effect upon the nervous structures that it would have if it circulated unchanged in the blood for a length of time.

Disease—Fever.—You know that during exercise the temperature of the body is raised, and how far this rise of temperature has to do with the oxidation of the alcohol I cannot tell at present, but we know that occasionally the temperature is very much raised in the human body when the patient is lying perfectly still in bed, as in cases of fever, and then the administration of alcohol is frequently not only of benefit, but it may be given in quantities that could not be borne by the same person if his temperature were not raised. In cases of fever, alcohol frequently seems to act not merely as a stimulant, but really as a food. The rise of temperature of the body, which tends to make alcohol inactive as an intoxicant and to change its character from a narcotic to a simple stimulant and food, also affects the actions of other drugs.

Ordinarily when digitalis is given to a healthy man it slows the pulse, but in cases of high fever it seems to have little power in this respect. The high temperature appears to destroy the action of the drug upon the vagus centre, through which it generally acts upon the pulse.

Certain other diseases modify the effect of drugs by altering their excretion. I have already mentioned the effect of conditions of the stomach and intestines in altering the absorption of drugs, but in cases where the kidneys are affected the disease may lessen the excretion of a drug and may tend to cause its accumulation.

Kidney Disease.—For this reason, we are told that opium and mercury ought to be sparingly and carefully used in cases of disease of the kidneys, because those two drugs are likely to have an unusually powerful action in such cases; the opium tending to produce coma and the mercury tending to produce salivation much more readily in persons suffering from kidney disease than they would do in ordinary conditions. But you must not push this rule too far. Here, again, it will be your duty to take into consideration the risk that the patient will run without the medicines, and I have seen men who were too much impressed by this dictum, so much so that they hesitated to give a mercurial purgative in cases of heart disease because a large quantity of albumin was present in the urine.

In such cases, the administration of a mercurial purgative is often followed by the very best results. It is not the administration of a single dose that you have to fear. What you have to attend to is the chance of a more or less continuous administration of the mercury bringing on salivation in patients with albuminuria, but the albuminuria in which the risk occurs is, I think, rather the albuminuria due to chronic renal disease than that which you find as a consequence of cardiac disease.

Time of Day.—Now the time of day has got a good deal to do with the effect of drugs. Just as alcohol is well borne when the temperature is high, so it is also well borne, and is, indeed, required as a stimulant, when the vital forces are low. The time when people are at their lowest is just about the small hours of the morning; that is the time when the patient is weakest, that is the time when it is coldest outside, that is the time when the watcher tends to get drowsy and when the fire in the grate tends to get low, and that is the very time at which you must pay most attention to keeping the room warm and to giving stimulants to your patient, if he has got a failing heart or failing respiration.

Primary and Secondary Action.—We have now to consider the primary, as distinguished from the secondary, action of drugs. The first effect of a dose of rhubarb, for example, is to cause an evacuation of the bowels; its secondary effect is to cause constipation, very likely lasting for two or three days. Morphine in small doses tends to cause stimulation and excited action of the brain, and in larger doses drowsiness or profound sleep, and in cases where the stomach is irritable it is one of the best sedatives and arrests vomiting. But if you give morphine to a healthy man for a few days, it is very likely indeed that when you stop it you may find the patient's stomach irritable; he feels sick, and very likely vomits. The primary effect of the rhubarb is generally stated to be due to its containing a purgative principle, viz., cathartic acid, and its secondary, constipating effect to its containing also an astringent principle, rheotannic acid. These two principles are supposed to act at different times, so that you get first of all purgation due to the cathartic acid, which is succeeded by the constipation caused by the rheotannic acid. Others, again, would give a different explanation, and would say that this one is not entirely true because you get constipation succeeding diarrhœa when you administer such a drug as castor oil, which contains no astringent principle. In the case where the castor oil has been administered it is supposed that the constipation that you get after the diarrhœa is simply due to a so-called reaction, that the motor powers become exhausted, and then they become sluggish afterwards, just as a man who has been engaged in very active and unwonted exercise for one day is apt to be languid, quiet, and disinclined to move on the next.

Action and Reaction.—But we must remember that, although we talk of the action of drugs, what we have really to do with is not simply the action of a drug *per se;* it is the reaction between the drug and the organism, and we may get alterations in the drug during its passage through the blood and tissues, just as we may get alterations in the tissues of the body caused by the drug. Morphine, for example, appears to undergo oxidation, and the products formed from it by this change have a tendency to act in a different way from the morphine itself.

These products of oxidation appear to be excreted by the mucous membrane of the stomach, and so after the first sedative effects of the morphine have passed off we have an oxidation product with an action very much like apomorphine, excreted into the stomach, and there it produces an emetic action.

We find that a number of drugs undergo changes in the body, many of them becoming associated with glycuronic acid ($CHO[CH(OH)]_4CO_2H$), a substance which tends to give a reaction very much like sugar. It may impress this upon your mind, if I tell you that some years ago the house physician in one of the wards said to me:—"How is it that such and such a patient always gets diabetes after she has taken terebene for her cough for two or three days?" We tested the urine, and, sure enough, we found a marked reduction occurring on boiling it with Fehling's solution. There was a little difference, however, to be noted between this urine and ordinary diabetic urine, for the precipitate of oxide of copper did not come down immediately. It wanted rather long boiling, and, in fact, it did not come down really till I had set the tube on one side; then we got a copious reduction. This was not due, however, to sugar; it was due to the fact that the terebene had become associated in the body with glycuronic acid, which it carried out along with it, and this glycuronic acid gave rise to the reduction.

Some other drugs enter into combination, forming sulphates in the body, and especially phenol and substances nearly allied to it. These form ethereal sulphates with sulphuric acid, and pass out in the urine as such. In this way they tend to take up the sulphuric acid, and, if they be present in large quantity, you get the ethereal compounds of phenol and its allies with sulphuric acid, completely replacing the ordinary sulphates in the urine.

Whenever this occurs, it is a sign of danger, because as soon as all the sulphuric acid is used up the phenol tends to produce symptoms of poisoning. Therefore if you were administering carbolic acid, either externally or internally, to a patient, and you wished to push it to the utmost without running any risk, you would keep a watch upon the urine, and see whether, from time to time, you could still get a precipitate of barium sulphate upon the addition of a solution of barium chloride If you found that the barium chloride no longer gave you a precipitate, you would know that the patient was in danger. But even in cases where phenol has been given up to the very verge of poisoning you can remove the risk by a free administration to your patients of soluble sulphates, such as sulphate of soda or sulphate of magnesia.

INTERNAL SECRETION.—We generally judge of the actions of our drugs by some external indication. When we give sulphate of magnesia, for example, we find that its administration is followed by a profuse discharge of watery fluid from the intestine. Thus we have evidently given a drug which has a purgative action. When we give spirit of nitrous ether or digitalis, or nitrate of potash, we find that the urine is increased, so we have evidence of a diuretic property residing in those drugs. When we give digitalis, or strophanthus, or convallaria, we find that the pulse becomes slow, so that we have evidence of the action of those drugs upon the heart. Until recently we were quite satisfied with recognising and studying such external effects of our drugs. Yet there was one class of drugs which, although it was very much used, gave no external indication of its action. This class was named "alteratives." Under the influence of drugs belonging to this class, patients began gradually to feel better, and yet there was no increase in the sweat, nor in the secretion of urine, nor in evacuations from the bowels, nor could any change be detected in the temperature, nor in the pulse rate, nor in the respiration. The action of alteratives was a complete puzzle, and now it still remains, to a certain extent, a puzzle, but we are beginning to see that it is an action which may be explained in the course of a few years. Till recently, in studying the physiology of glands, we thought only of their external secretion. This used to be very marked in the case of the liver, and for a long time the liver fell into great discredit and was said to be a perfect fraud; for although it was the biggest gland in the body, it could do nothing but secrete a little bile, which is of very little use to the organism at all. Bile had perhaps a slightly laxative action; it might tend to prevent decomposition in the intestine, but people could get along perfectly well without bile, and what good was the liver if this was all it could secrete? Then Bernard noted that the secretion of bile was a very small part of the liver's functions; that it bore about the same relation to the functions of the liver that the ashpit in a manufactory bears to the amount of work carried on in the manufactory itself.

But we were slow in applying this example to other glands, and we still looked upon the secretion by the pancreas of the juice which it poured out into the intestines as being its main function. Possibly it may be the most important function of the pancreas, but we now know that the pancreas has got a double function, and at the same time that it pours out this secretion, powerfully digestive indeed, into the duodenum it also pours back into the blood-stream through the lymphatics another secretion, which has the power of decomposing sugar, and which may be quite as important in the economy as the one that it pours out into the intestine.

In the same way, in regard to the intestine itself, we have been accustomed to look upon the secretion poured out under the influence of a dose of purgative medicine, the function of external secretion, as the great function of the intestine, but we must remember that at the same time that secretion takes place into the lumen of the intestine something else goes back into the blood, and it is quite possible that what is sent back into the blood from the intestine under the action of a dose of salts is much more important than what is poured out into the intestine and excreted from the body.

Processes of Tissue Change.—In the case of the stomach, we find that in the walls we have got chloride of sodium and we have got water, and that under the influence of a nervous stimulus these split up, and then we get in the interior of the stomach free hydrochloric acid. But at the same time we get passing out into the blood the sodium from which the chlorine has been split off, and this alkali tends to increase the alkalinity of the blood, and makes itself evident in the urine. I have frequently had patients come to me thinking there was something very wrong with them because they found that in the middle of the morning they passed urine which was quite thick—indeed, quite milky—when passed, and after standing it deposited a large flocculent white sediment. What they were suffering from was simply the ordinary alkalinity of the urine which comes on during digestion. They had secreted a large quantity of hydrochloric acid into the stomach to digest their breakfast, and a corresponding quantity of alkali had made its way into the blood, increasing its normal alkalinity and rendering the urine alkaline. After digestion is over, the hydrochloric acid is absorbed again, and then you probably find that the urine is more acid than before. Thus you get the so-called alkaline and acid tides in the urine.

Now, we know what takes place with salts, such as chloride of sodium, but we do not know precisely what takes place with another very important factor in digestion. We have not pepsin in the walls of the stomach, but we have got pepsinogen. During digestion this substance splits up, the pepsin goes into the stomach, but there is something else left which probably goes into the blood in the same way as the alkali of the salt does. We have pepsinogen splitting up and yielding an active ferment, and we have something else which we may call "ogen," or, still better, "X," because we do not know what

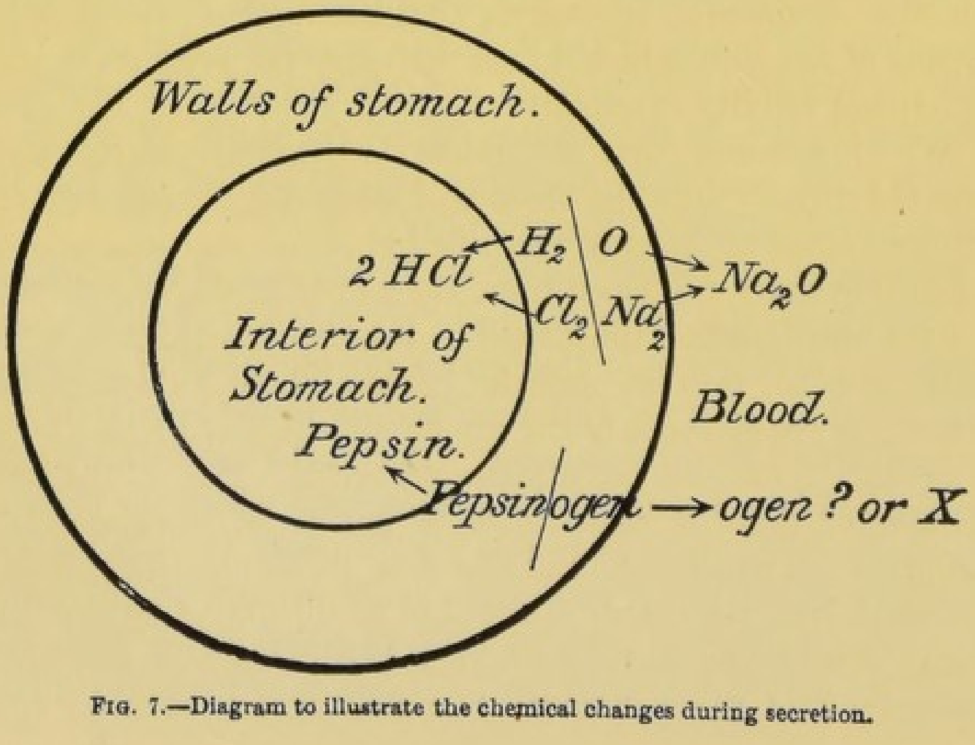

FIG. 7.—Diagram to illustrate the chemical changes during secretion.

it is, nor do we know what it does when it is set free by the pepsin being split off.

In all probability we have similar changes taking place in albuminous bodies generally. We know that during digestion such albuminous bodies as fibrin become split up during digestion and yield albumoses of different kinds; we know that these albumoses undergo further decomposition, and yield peptones, and that during absorption both peptones and albumoses are reconverted into albuminous bodies, either in their passage through the intestinal walls, or partly there and partly in their passage through the liver. Now, we know that the albumoses and peptones which are formed by the decomposition of albuminous bodies, although perfectly innocuous and excellent foods, and most useful for the organism when absorbed through the intestinal canal, are most powerful poisons when they are injected directly into the blood. If they are injected directly into the blood they will kill the animal, but these same bodies, if taken into the organism through the intestinal canal, instead of destroying it will preserve the animal's life. It is probable that what holds good for the secretions in the stomach, and for albuminous substances in it and in the intestine, holds good, to a certain extent, also for the albuminous substances that are broken up in those organs of the body which do not discharge the products of their functional activity externally.

We now know that the juices of various glands when injected directly into the blood will cause coagulation, and will kill an animal as quickly as a rifle bullet, yet these same juices when they enter the blood from the glands in the normal way, not too much at one time, tend to preserve the balance of the body and to prevent disease. When these substances are absent, in consequence of the atrophy of the gland which ought to produce them, we get diseases occurring. One of the most marked of those is that which is known as "myxœdema," a condition in which you find the face becoming thick, heavy, and mask-like, the colour of the skin pallid, excepting over the cheeks, where you have got a very bright red, and the whole appearance of the patient is like that of one suffering from severe renal disease, but you find no albumin in the urine. In such cases one finds that the thyroid gland is atrophied, and until within the last year or two the treatment of such cases was almost hopeless. We did not know what to do, but now by giving either an extract of the thyroid gland or the gland itself you see the thick, heavy look gradually disappear, the skin becomes normal, and not only do you find a change occurring in the face, so that the patient becomes once more healthy-looking, but you find that a change occurs also in the nervous system. The patient's ideas, which were previously slow, become quicker, and he re-acquires a bright, intelligent condition, which had almost gone during the time that the disease was at its height.

In another case, that of the supra-renal capsules, we find that atrophy of those organs gives rise to a peculiar bronzing of the skin, and that this bronzing is accompanied by great muscular depression, and finally by involvement of the digestive organs, so that there is almost always constant vomiting, progressive asthenia, and death. Under the influence of the extract of the supra-renal capsule, we find that such cases now begin to show either amendment or, perhaps, occasionally complete recovery.

In cases of so-called pernicious anæmia, we find that the patient becomes paler and paler, in spite of all we can do, the strength gradually wastes, and the patient dies. This used to occur in spite of every treatment, and sometimes occurs yet, but I have seen a case in which the only thing that was wanting to indicate that the case was one of pernicious anæmia was that the patient did not die. Some people may say this case cannot have been one of pernicious anæmia, because all such cases die ; yet this man certainly seemed as if he were going to die, everyone who saw him thought he was going to die, but he was put upon extract of bone marrow, and under this treatment he recovered.

There is another disease still, exophthalmic goitre, which is very difficult to treat, and even now we know very little about its treatment. I have only one case to mention, in which I gave the extract of supra-renal capsule, and under the influence of this extract the patient has gradually improved. How far she has got well I cannot say, because she improved so much that she ceased coming to the hospital. I may mention in this relation that the extract of thyroid has an effect upon the nervous system. In cases of exophthalmic goitre, where you find that the thyroid gland is very greatly enlarged, there is usually a curious excitability of the nervous system, so that patients may fear to cross a street, and are generally easily excited by the slightest noise or disturbance of any kind. Occasionally you may find that you have to stop the extract of thyroid gland in certain cases, because you find symptoms resembling those of exophthalmic goitre are brought on by it; that is to say, you get a curious excitability arising in patients, who were not previously nervous, after the thyroid gland has been administered to them for a certain length of time.

VENINS AND TOXINS; ANTIVENINS AND ANTITOXINS.—Now, we have noted that albumins are split up in various ways with the formation of poisonous bodies. It is possible that these poisonous bodies may be useful to the organism. Man rarely uses saliva as a weapon of defence, at least civilised people hardly ever do it, though occasionally uncivilised people spit in each other's faces. Saliva in man, when applied to the skin, is not likely to do any harm beyond that of causing mental irritation, but in some men the saliva has got something more than a disagreeable action. When inoculated under the skin of animals, it proves a deadly poison. The saliva in some men is almost as poisonous as the venom of a serpent. Now, in serpents the saliva is not always poisonous. There are certain serpents in which the saliva is not poisonous, but in others it acquires a tremendous toxic power, and this toxic power is dependent upon the presence in it of certain albumoses. Most of you know that the chemistry of albumoses and of peptones is exceedingly difficult, and that in all probability there are very many different kinds of albumoses and of peptones. You can readily see that if the splitting up of an albumin in the salivary gland of a snake be analogous to the splitting up of albumins in the intestine of a man, in the way we have just discussed, that there is likely to be given back into the body of the snake a something which will just be the complement of the albumose, and which, if united to it, would make the albumose innocuous. I do not think that I could show you this, so you will have to imagine it. Suppose I were to hit a glass bottle or tumbler (Fig. 8) with a hammer, and knock off a sharp,

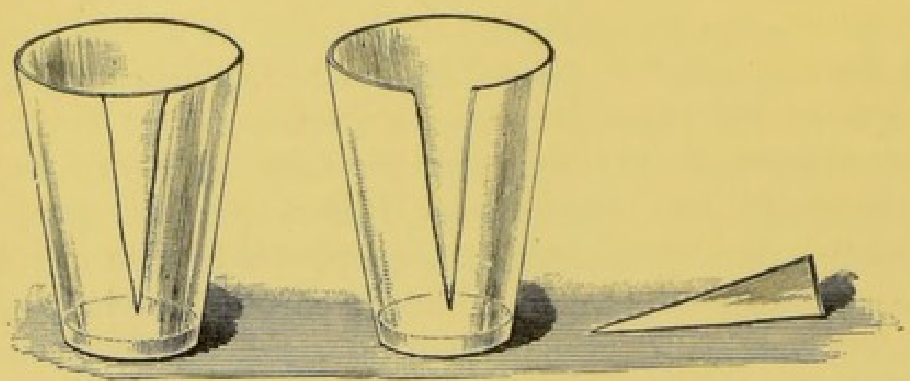

FIG. 8.—Diagram of a tumbler with sharp fragment broken out and replaced to illustrate the breaking up of an innocuous substance with formation of a dangerous fragment, and the reunion of this with another fragment to form an innocuous body again.

triangular splinter, that splinter would be exceedingly dangerous, and might prove a fatal weapon. The other part, not having a sharp point, would be comparatively harmless, and if the two were put together, so that the sharp splinter fitted in, we should again have something that was not at all dangerous. Now, something like this appears to occur in the case of the albumoses.

Suppose we were to split up an albumose, you would then have a sharp splinter which would be fatal, and we will call that venin. You would have also either one or more blunt parts which would not be dangerous, and we will call them antivenin (Fig. 9). Now, it is found that the blood of snakes

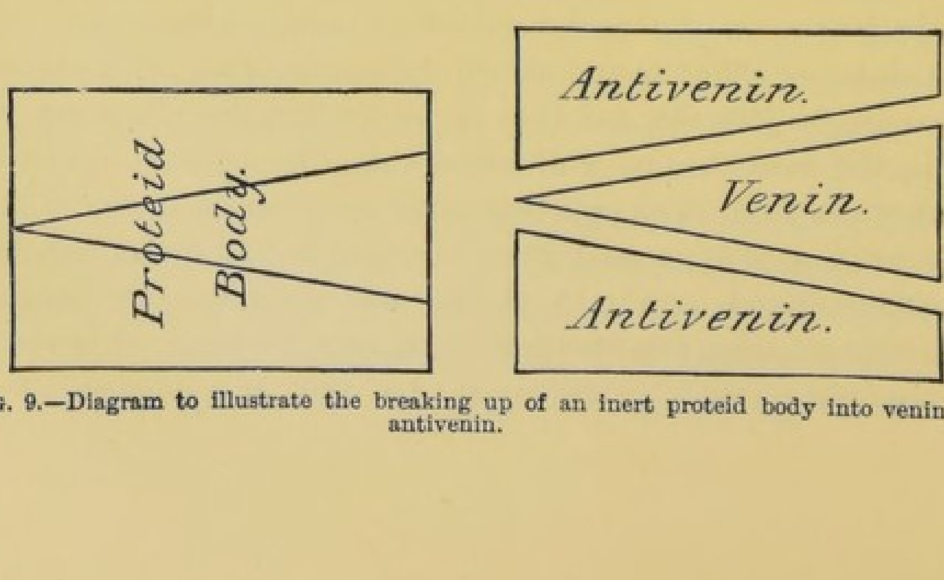

FIG. 9.—Diagram to illustrate the breaking up of an inert proteid body into venin and antivenin.

contains antivenin, and if you put into an animal small doses of venin, you can get antivenin formed. If you take a quantity of snake poison—it does not seem to matter whether it be that of a rattlesnake, cobra, or any other venomous snake—too small to produce death, and inoculate an animal with it, the animal does not die, the dose being too small. Wait a little while, and then inoculate a dose which would just be sufficient to kill it, if it had not had a dose before. The second dose does not kill it, and you may go on slowly increasing the dose until at last fifty times the fatal dose may be given to an animal without killing it. And then it is found that after the poison has been inoculated for a while, and the animal rendered immune, you may bleed the animal; you may take the serum, and you may inject it into a second animal, and thereby render the second animal immune. In the first animal you have formed antivenin, which is present in the blood, and when this is injected into the blood of the second animal it renders the venin which is subsequently introduced innocuous.

This is a chemical process, and not a physiological one, because Professor Fraser has found that if you mix the antivenin and venin in a test-tube before injecting them, you render the venin innocuous much more readily than if you inject the antivenin either before or after the venin into the body of the animal, although such injections will also neutralise the venin. Practically the venin and the antivenin in a test-tube neutralise one another, just as a little caustic potash and sulphuric acid will neutralise one another, forming a compound which has neither the caustic effect of the potash, nor the biting and injurious effect of the sulphuric acid.

Microbes and their Products.—I had occasion to tell you two days ago that man was not isolated; that his vital processes were just the same as those of the lowest organisms. Well, the lowest organisms also produce poisons in much the same way; they produce venins and antivenins.

Most of you know the great discussion that arose about the tubercle cure advocated by Koch some years ago, and the difficulties that were experienced in relation to an explanation of its possible action. Some considered that the alleged cure of tubercle was due to the substances formed by the tubercle bacilli and excreted externally by them; others attributed it to the substances formed in the bodies of the tubercle bacilli and retained within them. This cure has fallen into desuetude, but we still use, or rather we are beginning to use now pretty extensively, some other cures. Thus diphtheria produces, when the bacillus is inoculated into the throat of a child, a local inflammation with formation of a membrane. This local action may cause death mechanically by closing the air passages, but after the first effect has passed off, and the local condition has become completely well, the child may suffer from nervous symptoms: paralysis of various limbs, paralysis of the throat, and paralysis of the vagus nerve. These paralyses occur after all the bacilli have gone, and they are really due to degeneration of nerve trunks caused by a special poison which is formed by the bacillus. We are now able by inoculating animals with the diphtheria bacillus, or injecting into them the products of its life, to obtain a kind of antivenin, quite analogous to that which is obtained by the use of serpent venin; and now when a child is attacked with diphtheria we almost invariably inject into it the serum obtained from an animal which has been rendered immune to the diphtheria bacillus. The poison which the diphtheria bacillus forms, and which other bacilli form, is termed a "toxin," and the substance which is antagonistic to it is termed an "antitoxin." The terms venin and antivenin are applied simply to the poison of snakes, but the terms toxin and antitoxin are applied to the products of bacilli or other microbes.

These microbes are divided into various classes. One class requires air, another does not, and naturally this will tend to limit the part of the body in which the microbes can live and upon which they can exert their injurious action. Most of you know that the heart is liable to become diseased, not only in extra-uterine, but also in intra-uterine life. In each case the blood passing through the affected part is well aërated, but the part of the heart which receives the well-aërated blood is not the same before and after birth. After birth the aërated blood circulates in the left side of the heart, and it is the left side of the heart and the aorta that is liable to disease in extra-uterine life; but in intra-uterine life it is the right side of the heart which receives the aërated blood from the placenta, and it is this side which is liable to disease.

Now, although we may be able to neutralise the bad effects of microbes by means of antitoxin in many cases, yet it is always advisable, if possible, to prevent the formation of those toxins, and this is done by the use of drugs which will tend to limit the activity or destroy the life of the microbes before they have had time to form any toxins. Outside the body it is very easy to apply those substances which are known as antiseptics in any strength that we like, but we cannot do so if the microbes have once entered the organism, because if we use an antiseptic in too great quantity we shall not only destroy the microbes, but the organism itself. When I was a student I went one day to a debating society where there was to be a discussion on the trichina spiralis, that little worm that finds its way into the muscles and various parts of the body. One of my friends got up and said:—"Gentlemen, I am very much astonished that no one has thought of proposing an exceedingly simple and effective way of destroying this parasite. It has been found, gentlemen, that this worm dies at a temperature of 180°, and I therefore suggest that the patient should be placed in a warm bath, and his temperature raised to 180° F., and then the worms will all die." He did not think in the very least of what he meant by raising the temperature of the body of the patient to 180° F., which, put into plain language, simply amounted to boiling him alive. Well, the same thing happens in regard to antiseptics. If we give too much of our antiseptics to a patient, we run the risk of destroying him as well as the organisms. Outside the body, however, there is no risk of this sort, and we can therefore apply antiseptics freely.

LECTURE 4.

Microbes—Antizymosis—Antisepsis—Channels of entrance of microbes.

GENTLEMEN,

I do not know that we could fancy what London would be like if there were no sewers and no scavengers. In comparatively few days the place would be uninhabitable, and the same thing would have happened to the world at large if there were no scavengers in it. Fancy, if you can, what the world would have been if every dead animal, large and small, and every dead plant were still lying where it had fallen as it died: there would be no room left for the living.

MICROBES.—Now the scavengers of the world are the small organisms which are known as micro-organisms or microbes. They break up dead plants and dead animals, and thus clear them away, but just as a dustmaid's cloth sometimes not only clears away dust, but breaks away little bits of valuable porcelain, so those microbes sometimes overstep what we human beings regard as their legitimate function, and they do what we consider to be harm instead of good. Whether that is to be looked upon as harm from the microbes' point of view is quite a different thing, but from our point of view they certainly do harm. On account of their different functions, they have been subdivided not only into aerobic and anaerobic, as I mentioned before, but into saprophytic and pathogenic. The saprophytic organisms attack dead matter, but the pathogenic first of all attack living matter and strive to kill it, and then continue to attack it after it is dead. Sometimes an organism may have both functions. It may be unable to attack living matter fully alive, but yet it may be able to get a resting-place in portions of tissue that are partially dead.

A very interesting experiment was made by Chauveau, who found that certain organisms injected into the blood of a living animal produced little or no effect, but when the animal was treated by the process of castration, common in France, the testicles, which were killed by the process, were attacked by the organism. This process of castration differs from ours in this particular, that the testicles are not removed, but the scrotum and testicles are severely twisted, so that the blood-vessels are really destroyed, and the testicles, having their blood supply stopped, become dead. They do not suffer from putrefaction if there be no organisms in the body, but if microbes, which produce it, are introduced into the blood, they attack the dead testicles, find in them a lodgment, and destroy the tissues of which they are composed, although they still remain within the living body.

Microbes may be divided in various ways. Practically, those that concern us are (1) the yeasts, (2) the moulds, and (3) the bacteria. The bacteria may be further subdivided, according to their forms, into (*a*) the short, stout ones, or bacteria proper; (*b*) the bacilli, which are longer and thinner ones; (*c*) the spirilla, which are more or less wavy; and (*d*) the cocci, which are the shortest of all, and are almost completely round (Figs. 10–12). These micro-organisms usually grow and multiply

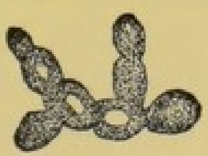

FIG. 10.

Blastomycetes, or Yeasts	Torula, or Saccharomyces (Fig. 10). or Mycoderma.

FIG. 11.

Hyphomycetes, or Moulds	Mucor. Penicillium. Oïdium. Achorion. Trichophyton. Microsporon.

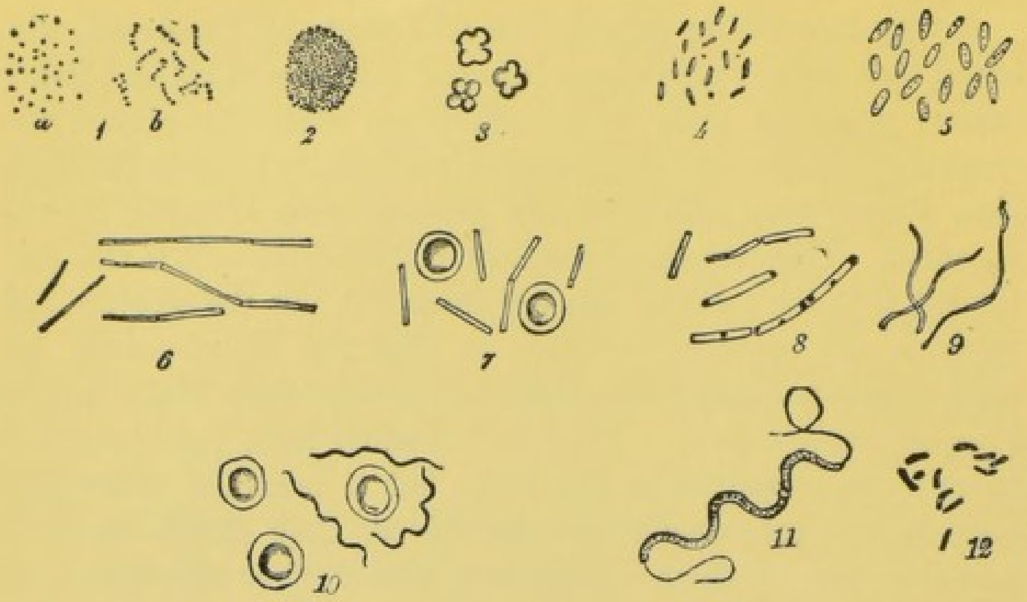

FIG. 12.

Schizomycetes, or Bacteria ...	Sphærobacteria (globular cells) ...	Micrococcus (1 (*a* and *b*) and 2, Fig. 12). Sarcina (3).	
	Microbacteria, or Bacteria proper (small, rod-like cells)	Bacterium	Bacterium termo (4). B. lineola (5).
	Desmobacteria, or Filobacteria (larger rod-like or thread-like cells)	Bacillus (straight) ...	B. subtilis (6). B. anthracis (7). B. septicæmia. B. malariæ (8). B. tuberculosis (12). B. lepræ.
	Spirobacteria (twisted or spiral cells) ...	Vibrio (wavy)	Vibrio serpens (9).
		Spirochæta (long, flexible, close-wound spirals)	Spirochæta Obermeyeri (10).
		Spirillum (short, stiff, open spirals)	S. volutans (11).

either (1) by growing longer and then subdividing, so that you have got a number of individuals, or (2) by forming spores in their interior. Then, when the individual dies, the spore is freed, or it may be freed even during the life of the individual. These spores have this important property in relation to our subject, that they resist the action of various agents much more than, and are not nearly so easily killed as, the microbes themselves. In the process of their growth these organisms assimilate food from the media in which they are growing. But not only is it true that the highest and the lowest organisms are alike in many respects, but the smallest and the largest are also alike, and I never hear of the effect of bacilli or of micro-organisms in general upon the nutrient media in which they live without thinking of the effect of a herd of elephants upon a rice-field. When a herd of elephants gets into a rice-field, the animals eat up a quantity of the rice, but they destroy about a hundredfold more than they consume, and the same is the case with these micro-organisms. They consume a small quantity of nutriment, but they split up and destroy, perhaps we may say, a thousandfold more than they consume. The products which they form by destroying the nutrient media are, to a great extent, injurious to those microbes themselves. Thus the yeast-plant splits up sugar and forms alcohol and carbonic acid. The alcohol that it forms is injurious to the plant, and when it has accumulated in the fluid to a certain proportion, the yeast-plant ceases to grow, and finally dies ; and the microbes which feed upon proteid substances tend to form from these proteid or albuminoid substances various bodies of the phenol series which are really antiseptics, and when they have accumulated to a sufficient extent they will destroy these microbes themselves.

Now, it very often happens that the products formed by one set of microbes are favourable to the growth of another set; so that alcohol, which is injurious to the yeast-plant forms a favourable soil for the micro-organism which produces vinegar, which in its turn proves fatal to the plant which gives rise to it, but again affords a favourable soil for another microbe which forms a sort of gelatinous substance.

There is a struggle for existence between the microbes, just as there is between higher animals, and if a number of mixed microbes are planted together in a nutrient medium, those will succeed first to which the medium is most favourable, and they seem to choke out the others just as a luxuriant crop of wheat may choke the weeds, but, on the other hand, if the soil be more favourable for the second set, they may choke out the first, just as the weeds, under certain circumstances, choke out the corn.

Ferments.—Now, how do these microbes live? They live in much the same way as the elephants. They ingest, digest, and assimilate their food, and they do so by means of enzymes or ferments. Enzymes, as you know from your study of physiology, are the substances present in the various juices which have the power of splitting up other substances. A good example of them, as you know, is pepsin. I have put here a lot of fibrin, which I have coloured with some aniline-blue, so that you may see it more readily. The fibrin has been placed first of all in some dilute hydrochloric acid, so that it has swelled up and become somewhat translucent. I will now pour over it a little solution of pepsin, and you will probably find that as the hour goes on the pepsin will begin to act along with the hydrochloric acid on the fibrin, so that it will become dissolved. You will notice that the first fluid that passes is a little of the pepsin which I have poured in. It is hardly coloured, but as the process of digestion goes on it will be more deeply coloured, and the quantity of fibrin will get less and less, and the whole mass becoming more or less liquefied. You see that the pepsin acts perfectly well although separated from the pig which formed it, and which was killed long ago. But the pig from which that pepsin was got had other ferments than pepsin inside its body when it was alive.

Microbes seem to have two sets of enzymes, one of which they are able to excrete and which will act outside of them, and another which is retained in their bodies and acts inside them. Thus the yeast-plant secretes an enzyme which has the property of inverting sugar, and which passes out from the yeast-plant into the solution in which it is living. But we have not yet been able to isolate the substance by which the sugar is split up inside the yeast-plant, although in all probability that also is an enzyme which is retained in the cells of the yeast, and only acts within them.

Indeed, I daresay you have heard of the great dispute which occurred about enzymes and ferments. For many years ferments were looked upon as substances having a peculiar commotion in their particles, as it was termed. This commotion they had the power of communicating to other substances, so that the atoms of which the other substances were composed were shaken apart, and the substances thus decomposed. Some 20 years ago Pasteur showed that fermentations were almost always connected with living organisms, and a great dispute arose between him and Liebig, who held the view that fermentations were not necessarily connected with living organisms.

For a good while Pasteur seemed to have the best of it, and even now you will find that fermentation is looked upon as a process connected very closely with life and dependent upon the presence of living organisms. Shortly before his death, however, Claude Bernard seemed to have become aware that Pasteur, although seeing a great truth, had only seen part of the truth, and it would be very interesting for those of you who read French fluently to take a look at Pasteur's criticisms on the posthumous papers of Claude Bernard. Bernard seems to have recognised that although fermentations are due to organisms, nevertheless these organisms carry on this fermentation by means of enzymes, which they either excrete or retain within them. Thus we are to a great extent returning to the old view, the view which Liebig founded upon the fact that one enzyme, viz., diastase, had been separated from malt and could act independently of the malt. In the grain of germinating wheat, besides diastase, there is another curious ferment which has only been recently isolated. There is a little cellulose envelope in the grain which keeps the starch of the grain apart from the diastase, which is thus prevented from acting upon it. A special ferment produced in the germinating grain dissolves this envelope, and thus allows the diastase to attack the starch. But it is only within the last few years that this ferment has been isolated, and in all probability as chemical knowledge progresses we shall be able to isolate the ferments which as yet remain undiscovered in the bodies of the microbes, and which enable them to carry on their fermentative functions.

Classes of Ferments.—Ferments have been divided into two classes: (1) organised ferments; (2) unorganised ferments, or enzymes. By organised ferments we mean the definite microbes which produce fermentation; by enzymes we mean chemical substances obtained from living beings, but which are not themselves alive. As an example of an organised ferment we may take yeast, and as an example of an unorganised ferment, or enzyme, we may take pepsin.

Action of Drugs on Ferments.—These different classes of ferments are attacked in different ways by various drugs. There are some drugs which affect both almost alike. For example, corrosive sublimate destroys enzymes and destroys organised ferments. Chlorine, bromine, and iodine have all a somewhat similar action, so has sulphurous acid. These attack enzymes as well as ferments. But there are other substances which attack organised ferments while they have but little or no action upon enzymes. A substance of this kind is chloroform, which hardly affects pepsin or any of the enzymes, but has a most powerful destructive action upon various microbes. Other substances of the same class are creosote and carbolic acid.

But the great destructive agents to organised ferments or microbes are heat, light, and air. There is a certain temperature which aids their action, but if you go above that temperature you destroy them, and one of the most successful ways of destroying microbes is to subject them to great heat, and especially to moist heat. Dry heat will kill them, but it will not kill them so readily as if the heat be moist, because the changes in the chemical constitution of the body of a microbe are not easily carried on in a dry condition.

You all know the effect of very dry air in preventing change in seeds of the higher plants. We have all heard of mummy wheat. How long the mummy wheat will continue to retain life I do not know, but probably dry wheat does retain its vitality for a very considerable time, whereas if the same wheat were kept at a similar temperature, but moist, it would probably either begin to germinate or begin to decay in very much shorter time, and what happens to the wheat happens to microbes also. Heat, either moist or dry, is one of the most powerful destructants to microbes.

Light has a particularly harmful action upon many microbes, and some year and a half ago a most interesting experiment was shown of taking photographs by means of microbes, using a plate of gelatine upon which microbes had been sown in place of an ordinary sensitised photographic plate. In the negative the parts which had been acted on by strong lights had become opaque and would not allow light to pass, while those parts which corresponded to dark parts of the object photographed were transparent and allowed light to pass freely. The transparent part of the negative would consequently allow a sensitised paper placed below it to become dark and form the shadows of the photograph corresponding to those of the object or scene which had been photographed, while the dense part of the negative, by hindering the transmission of light through it, would produce light places in the sensitised paper. When the negative was placed over a gelatine place upon which microbes had been sown they grew on those parts of the plate which were under the opaque parts of the negative, and thus formed the lights of the positive picture; but on those parts which were under the transparent parts of the negative they did not grow, and the dark colour of the gelatine plate, unmodified by the microbic growth, formed the shades of the picture.

Fresh air, or, as we may say, oxygen, is also destructive to microbes. They want a certain quantity of oxygen, but if you give them more than enough it is most injurious to them. Thus it happens that microbes do not thrive very well in running water, where the water, being in constant motion, is exposed to the action of light, and takes up air in the form of bubbles. Thus you get both light and oxygen freely acting upon the microbes, whereas if you put some microbes in the same water, but keep it in a tank and cover it up from light, the microbes will grow.

Antizymotics; Antiseptics; Disinfectants; Deodorisers.—Drugs or agents which will act upon microbes are divided into (1) antizymotics, (2) antiseptics, (3) disinfectants, and, finally, as a side class, (4) deodorisers.

Antizymotics are substances which prevent fermentation, and the most typical of them is corrosive sublimate, which prevents the action both of enzymes and zymogens.

An antiseptic is a substance which destroys those microbes or organised ferments which produce putrefaction.

Disinfectants really form a subdivision of this class. They are substances that possess a special power to destroy those microbes which tend to produce disease.

Deodorisers are simply those substances which take away the disagreeable smell which frequently accompanies the decomposition of substances, and especially of those of an albuminous nature, under the influence of microbes. But a deodoriser, while making the neighbourhood rather more pleasant, does not necessarily make it any more safe.

Amongst the antiseptics, the substances which belong to the haloid series, chlorine, bromine, and iodine, are especially important. Along with them we may take sulphurous acid and the substances from which these haloids or from which sulphurous acid can be readily got. To these we may ally also various bodies belonging to the phenol series: creosote, carbolic acid, salicylic acid, and the like. Then we have various salts of heavy metals, and especially of mercury, though salts of zinc, salts of copper, salts of silver, are more or less antiseptic. All antiseptics are also disinfectants, because antiseptics destroy microbes generally, and the pathogenic microbes, which give rise to disease, are only a subdivision of microbes generally.

Amongst the various deodorisers four of the most important are sulphurous acid, carbolic acid, bleaching powder, and ozone.

We are able to use chlorine and substances which produce it very freely outside the body; and in order to disinfect sewers, privies, and so on, chloride of lime is one of the substances most commonly employed, and it has the further advantage of being also a deodoriser.

Struggle between Microbes and Organism.—When microbes enter the body they have a struggle with the cells forming the tissues, and sometimes the microbes get the upper hand and damage or destroy the body; sometimes the cells of the organism get the upper hand, and then they destroy the microbes.

Channels of Entrance of Microbes.—There are various channels through which microbes may gain entrance. They do not gain entrance at all readily through the unbroken skin, but if they get into a crack they may lodge there, and thus gain an entrance. Still more readily do they gain it from a punctured wound. They may gain entrance also through the respiratory passages: through the nose, through the ear, through the bronchi, and through the lung; or from the digestive passages: from the stomach or from the intestines; or they may gain an entrance through the genito-urinary passages, especially through the bladder.

After they enter the body, or rather after they lodge upon one of the mucous membranes, they may produce local changes which will be very injurious; and it is, therefore, advisable, as far as possible, not only to destroy the pathogenic microbes before they enter the body, as in sewers, in privies, in drinking water, and so on, but to destroy them just at the moment that they are trying to effect an entrance into the body. Sometimes pathogenic microbes are conveyed by means of instruments used by a medical man, or even by the finger of a medical man himself; and, therefore, it is highly advisable that both instruments and fingers should be thoroughly disinfected. I lay more stress upon this because I have known of some sad cases in which the rule has not been followed, with the most disastrous results. Some forty or fifty years ago there was a great epidemic amongst the lying-in wards in Vienna. As many of you know, very large numbers indeed of women come to the General Hospital in Vienna to be delivered, and there had been case after case of puerperal fever, so that the mortality was simply appalling. One of the professors, on thinking over the causes of this mortality, recollected that many students came up straight from the Pathological Theatre to the lying-in wards, and made vaginal examinations of the patients. When I was in Vienna there was no general water supply to the city, but all the water was drawn from wells, so that the supply of water for washing the hands of the students was very scanty. In the Pathological Theatre there was a vessel with a small spout and a tap, and a little basin beneath. The students simply turned on the tap, and a few drops fell upon their hands, and they then wiped them upon a towel. The professor thought that probably the epidemic was due to the action of pathogenic material from the Pathological Theatre, conveyed to the women in child-birth by the students, although this was before the days when one recognised microbes as being the cause of infective diseases. The professor made every student who had been to the Pathological Theatre wash his hands in a solution of chlorinated soda before coming to the lying-in wards, and in a very short time the epidemic disappeared. I remember, too, when I was a student, another accident of the same sort happening in the practice of an obstetrician; and as everyone was talking about it at the time, it was impressed upon my memory. This man had a very large obstetric practice, and somehow or other he got a case of puerperal fever, and then case followed after case, until he was driven to distraction. He left his practice, got another man in, went away, and when he came back, although everything had been going on well during his absence, the epidemic recurred at once. He had changed all his clothes; he had, as he thought, disinfected himself, until one day it occurred to him that he had not burnt his gloves. What had happened was this. In one case of puerperal fever he got his fingers infected with the pathogenic material; he had put on his gloves without thoroughly washing his hands; the interior of the gloves became infected, and every time he put on his gloves the fingers got re-infected afresh, and brought this epidemic about. But after the gloves had been burnt the epidemic ceased. It is quite possible that some of you might do something similar, not with your hands—because I trust you will remember these cases and disinfect the hands—but with a thermometer. I have seen doctors put a thermometer into a patient's mouth, and then, instead of washing it, drop it back into the thermometer case. Sometimes it may have been wiped again afterwards, but sometimes I think it was not. At all events, you can quite readily see that if you were to do this with a patient suffering from some infective disease, such as scarlet fever or some disease of the mouth, you might convey the infection to others. Let us say that you take the temperature of a patient with syphilis with your thermometer, and, instead of carefully washing it afterwards before putting it into the case, you put it into the case and shut it down. You may wash the thermometer next time when you put it into the patient's mouth, but you may forget that the case is infected, and the thermometer is liable to re-infection every time it was put into the case. The same may be said of a spatula or of other instruments which one uses for the throat. An instructive case occurred in the experience of a friend of mine, who had a country practice at the time and had long distances to ride. One of his best patients was an old gentleman who lived a good long way off. The old gentleman suffered from enlarged prostate, with retention of urine, and my friend occasionally had to pass a catheter. One day he passed the catheter, drew off the patient's urine, but in two days afterwards the old gentleman died. The catheter had not been cleaned, the microbes on the catheter had set up putrefaction in the urine contained in the bladder, and the septic products thus formed, being absorbed, had killed the old gentleman. You must remember that scrupulous cleanliness is of the utmost importance.

Antiseptic and Aseptic Surgery.—Now it is the application of these principles to surgery that has rendered possible the extraordinary operations that we now see done upon the brain, upon the spinal cord, and upon the abdominal organs. When I was a student I remember well Professor Syme saying, "Ovariotomy is not surgery, it is murder, and any man who attempts to do it ought to be hanged." And he was so far right. Ovariotomy at that time was almost murder, so much so that in the hospital in Edinburgh it was utterly forbidden. It was not allowed because it was looked upon as an unjustifiable operation, nor was it to be wondered at. In the days before antiseptic surgery, a thrill of horror used to run through everybody when the word went round that pyæmia had got into the hospital, for we knew that case after case would die. I well remember a man being brought in who had just struck the end of his thumb as he was driving in a nail. The last phalanx had to be amputated—a very simple operation with a somewhat small wound, and now-a-days you would be quite sure that it would go right. That man died of pyæmia, and in many other similar cases the slightest wound would bring about the death of the patient.

The researches of Pasteur stimulated Lister to investigate the causes of pyæmia and such other surgical plagues, and having found out that they were due to microbes, he introduced the plan of trying to destroy the microbes before they gained an entrance into the wound. The apparatus that he employed was at first clumsy, and amongst other things he used a carbolic acid spray, which played upon the operator and upon the patient. Now-a-days that spray may seem absurd, but I believe at the time it was necessary; and if the spray had not been used, I question whether antiseptic surgery would now be where it is, because the conditions under which men operated in those days were entirely different from what they are now. Now we find that the operating theatres are completely aseptic: they are free from germs; in those days everything was loaded with germs: the walls, the floors, the ceilings, everything was filled with germs. The dust which arose from the floor was quite enough but for the spray to have poisoned a wound. At the present day the necessity for the spray does not exist, and it has been got rid of. More than that, instead of using *anti-septics*, we now to a certain extent go in for *aseptic* surgery, which means that, instead of applying drugs to the wound to kill microbes as they rest upon it, we take care that, if possible, no microbes shall ever reach the wound. We take the greatest possible care that all microbes shall be destroyed beforehand, and that not a single living microbe shall come ever into contact with the tissues of the body.

Now this is another great step. The first step was from septic surgery to antiseptic surgery; the second advance was from antiseptic surgery to aseptic surgery. The reason why aseptic surgery is better than antiseptic surgery is this: that those drugs which destroy the microbes tend to destroy also the living tissues of higher animals, and if you have got an open wound with microbes upon it, and you apply an antiseptic to this wound, you are, no doubt, tending to destroy the microbes, but you are tending to destroy also the living cells which compose the tissues of the body, and thus to weaken their resisting power. You will remember what I told you about that experiment of Chauveau: how the weakened and dead tissues have not the same power of resisting the action of microbes as the living ones have.

Respiratory Passages.—We are very often called upon to destroy microbes as they are gaining entrance to the body through other channels than open wounds. One of the most common ways of entrance into the body is through the nose, and you know how troublesome colds in the head are, how liable they are to pass down to the trachea and bronchi, and what a number of deaths they occasion. Now we can often stop a cold in the head by using antiseptics, and one of the readiest ways of doing so is, I think, to use a spray consisting of menthol and paroleine, three parts of menthol to 100 of paroleine. We will take this up more fully when we come to discuss the action of drugs on the respiratory system. But why is it that you do not get cold sitting here, for example, in a warm class-room? And yet if a chink of a window were opened, and a little draught were to play upon you, you would very likely catch cold at once. I believe the reason to be simply this: that the tissues in a man exposed to a draught have their resistance weakened by it, so that they are no longer able to resist the attacks of the microbes. If you inoculate a fowl with anthrax it does not become ill, but if you stand that fowl with its feet in water and chill it down it will succumb to anthrax readily enough. And so a man in health will not be attacked by the microbes which are taken into his nose during respiration; but if he is chilled down he will be attacked by them, and may very likely be seriously ill; and the same thing holds good in regard to pneumonia. The cocci which give rise to pneumonia are probably inhaled by many of us day after day with no bad result, and yet if we were to get thoroughly chilled down by sitting in wet clothes, any one of us might then get pneumonia; so that it is advisable always, in order to prevent microbic infection, to keep the organism in the best possible condition.

Digestive Canal.—When the microbes pass into the intestinal tube, many of them are no doubt destroyed by the gastric juice. It was shown many years ago by Beaumont that gastric juice which he obtained from Alexis St. Martin had the power of preventing putrefaction, and many microbes are destroyed in the healthy stomach. We find, however, that some microbes may grow and thrive in the stomach, especially when it is out of order. When there is catarrh of the stomach, and the gastric juice is less acid than it usually is, many of the microbes may grow and thrive, even although there be a considerable proportion of acid present, provided the acid be not hydrochloric acid, but consist of some organic acid.

In order to check fermentation in the stomach, then, we very frequently give antiseptics. Two of the most common antiseptics that we employ are carbolic acid and sulphurous acid, carbolic acid in the form of pill, sulphurous acid in the form of a draught. And occasionally the results obtained from sulphurous acid are simply wonderful. In those patients who have had a large amount of fermentation going on in their stomachs, with the result that they vomit freely, the vomiting is at once checked and the formation of decomposing products is arrested by the sulphurous acid, especially when this is given after the stomach has been washed out. Now, sulphurous acid, as I have said, is an exceedingly good antiseptic and disinfectant, and not unfrequently it is employed to disinfect rooms. In doing this one burns the sulphur in an iron pan in the middle of the room, and after closing the doors and windows one leaves the room to become filled with the sulphurous acid. There is one precaution, however, to be taken, and that is that under the iron pan you should put some water. The readiest way of employing the disinfectant is to take a tub, half fill it with water, put the tongs and the poker across, and then put your iron pan on the top of the poker and tongs, so that if any of the sulphur should by chance get over the side of the iron pan it will fall into the water, and not upon the floor. Owing to the want of this precaution, a friend of mine nearly had his house burnt down. He wanted to disinfect one of his rooms, and he burnt sulphur according to rule, but without the precaution of putting the water underneath. The burning sulphur somehow or other got over the side of the pan, set fire to the floor, and the whole room was soon in a blaze, and if it had not been very quickly discovered the house would have been burnt down.

In the intestine we use as disinfectants carbolic acid, creosote, salicylic acid ; a very good one also is salol. Salol is really the salicylate of phenol, and when it is acted upon by the alkaline pancreatic juice it becomes split up and yields salicylic acid and phenol, both of which act as powerful antiseptics.

Ptomaines and Leucomaines.—Now antisepsis in the intestinal canal is a question of very considerable importance, because upon the peculiar decompositions that go on there a great deal of diarrhœa depends, and not merely diarrhœa, but probably a great amount of general discomfort and malaise, because, as I mentioned to you, microbes give rise to poisons, poisons which are injurious to them, poisons which are also injurious to other cells. Amongst the poisons that are formed by microbes is one alkaloid, viz., muscarine, which is also found in poisonous mushrooms. When poisonous mushrooms are eaten violent vomiting and purging usually sets in, and along with this we frequently find a condition of collapse almost exactly like that produced by Asiatic cholera, the patient's face becoming pale, the surface cold, and the pulse weak. Now muscarine has been shown to be one of the products of decomposition of albumin, and it appears to be formed every now and again in the intestinal canal.

Besides muscarine, various other alkaloids are formed by the decomposition of albuminous substances through the agency of microbes, and these are known usually under the name of "Ptomaines." But it is not microbes alone that form alkaloids: the cells in the living body of animals appear to form alkaloids as well as microbes and higher plants, and to distinguish these from ptomaines they are known as "Leucomaines." Both the ptomaines and the leucomaines may be excreted from the body just as any poison injected under the skin or injected into the blood may be excreted by the kidneys or by other eliminating organs. If the excretion should take place rapidly no harm may be done, but if excretion be retarded you may get actual poisoning occurring, and the same thing takes place if the poisons are formed too rapidly and absorbed too rapidly to allow of their excretion.

There is another way of stopping the formation of ptomaines in the intestinal canal than by destroying the microbes by means of antiseptics, and that is by starving out the bacilli. Bacilli have a way of living upon certain substances, and if you constantly change their food they are unable to adapt themselves to the change, and they die. If you change their food very gradually they seem to have a power of adaptation, and will thrive upon the new food after a while, but if you change their food very quickly they are unable to do so.

Now one of the conditions that is certain to engage your attention to an enormous extent when you come into practice is the diarrhœa which occurs in children. The disease causing the greatest numbers of death among children in the Registrar-General's list is infantile diarrhœa. Very large numbers of children die before they are five years of age, and this diarrhœa depends in most cases upon putrefaction or fermentation going on inside the intestinal canal. We very frequently try to check it by various antiseptics, but sometimes without success, and a plan that is often followed is simply to change the food entirely, and in place of giving the child milk, which it has had before, to alter from the nitrogenous milk, to a farinaceous diet, such as barley-water, and then again to alter from the barley-water to another diet containing also nitrogenous material, but of a different character, namely, the white of egg beaten up with water. Sometimes you may find that the change simply from the milk to barley-water will suffice, and then after a while you change back to the milk again.

I must mention here that perhaps the greatest cause of infantile mortality that one knows is a particular kind of feeding bottle. We all know that in the Napoleonic wars the number of men who died was almost inconceivable, and yet I believe that this kind of feeding bottle is responsible for more deaths than the guns of Napoleon and all his generals. The bottle in itself is particularly ingenious and convenient, and is in itself no more dangerous than Napoleon's cannon when they were used simply to fire salutes. In the case both of the feeding bottle and the guns it is the way they are used that causes the deaths. This particular kind of feeding bottle is, as I just said, exceedingly convenient, and for that reason is very much used. It is a bottle in which there is a long tube which goes down to the bottom, and is connected to a piece of indiarubber tubing with a teat at the end. The particular objection to this arrangement is that very great care is required to disinfect the tube, and people as a rule are so careless that although the bottle itself may be thoroughly well washed, you almost invariably have organisms or their spores either in the glass tube or in the indiarubber tube. You can readily see that if this be the case, the milk which is drawn into the child's mouth through it will be infected as it passes along. The milk may be perfectly fresh when it is put into the bottle, and any portion of the same milk after an hour or two may be perfectly fresh in a vessel outside, yet the portion in the child's stomach may have become perfectly sour, as the warmth is favourable for the growth of the bacilli with which the milk has been inoculated during its passage through the tube. We have been hearing a good deal lately about child murders, but the number of children that are murdered in this way is incredible. Many of you will see mothers bringing children with diarrhœa to the casualty department of this hospital. Whenever a child comes with diarrhœa, mind you ask to see the feeding bottle, and probably in nine cases out of ten, if you take the cork out and smell the bottle, you will notice that it has a very sour smell. You will generally smell lactic acid, but not unfrequently you will also smell butyric acid. If you want that child to improve, you must tell the mother to discard the bottle with the long tube entirely, and get one of the so-called slipper bottles, in which the teat is fixed directly on the bottle itself. In this kind of bottle there is very little chance of microbes escaping destruction if ordinary cleanliness is used. It is advisable always to tell the mother to have two teats, and to keep one in a disinfecting solution, such as permanganate of potash. In this way one can always be kept really clean and ready to be put fresh in the bottle when required. In this way you will greatly reduce the mortality amongst these children, though whether this is an advantage or not is another question. Any of those who are interested in the subject of antiseptics, and would like to study it further will find it more fully dealt with in my "Croonian Lectures on Modern Therapeutics."

LECTURE 5.

Antisepsis, *continued*—Phagocytosis—Action of drugs on blood.

GENTLEMEN,

The gastro-intestinal catarrh which is produced by decomposing milk gives rise to pains and cries on the part of the child, which are frequently concealed by the administration of soothing syrup, with the result that the child ultimately dies. In order to prevent this condition of things, you may give, as I have said, various antiseptics, and amongst those I mentioned salol and salicylate of bismuth as being very useful. These two drugs go very well together. Salol, as I said, is decomposed in the intestines, and splits up into phenol and salicylic acid, both of which are powerful antiseptics. Another antiseptic that is frequently employed is β-naphthol, and another substance that is often used is naphthalin itself. This is an almost insoluble powder, which has a disagreeable odour of its own, but if it is concealed in a cachet it is readily taken, and it has perhaps a greater power of deodorising disagreeable motions either in the child or in the adult than anything else with which I am acquainted. It is given in doses of half a grain to 10 grains, according to the age of the patient, either in a cachet or in a little bit of wafer paper. These drugs are, perhaps, amongst the most powerful of the intestinal disinfectants, and by means of them one is able frequently to prevent a good deal of the discomfort that arises from sepsis in the intestines. You can readily see that sepsis occurring in the intestines is likely to be followed or accompanied by various general symptoms, because the products of septic change in albuminous substances are, as I have already mentioned, of a poisonous nature. Many of them belong to the class of so-called toxic amines, or toxamines. One of these amines has received the name of tyrotoxicon. It is produced by the decomposition of cheese or even of milk, and it acts on the intestine, and causes violent diarrhœa or even collapse. Some toxamines act especially upon the heart, and others upon the nervous system, so that frequently one is able to cure symptoms of general or circulatory nervous disturbance either by giving antiseptics to arrest putrefactive processes in the intestine, or by another very simple old-fashioned plan, viz., by sweeping out the whole of the intestinal contents by means of a blue pill and black draught.

It is to be noted that in the old-fashioned plan of giving calomel, followed by a saline, we are doing two things: we are clearing out from the intestinal canal all the microbes and the products which they have formed, and at the same time we are employing a drug which has a very powerful antiseptic action. One of the most powerful of all antiseptics is, as before stated, perchloride of mercury. It has this disadvantage, that, being a very soluble substance, it acts on the stomach and its contents, so that its action is thus weakened before it gets into the intestine. Nevertheless, only a part of it, and not the whole, is thus spent, and so perchloride of mercury has also a powerful antiseptic action in the intestine, and on this account it appears to be a very useful remedy in typhoid fever. In the case of calomel, which is a very insoluble substance, it appears that part of it is converted into the perchloride of mercury in the intestine itself, and so it has a powerful disinfectant action. So that small repeated doses of calomel, or small repeated doses of grey powder, are frequently useful as intestinal disinfectants, and here again we find that small doses of grey powder have been for a long time very generally recognised by old-fashioned practitioners as exceedingly useful in cases of infantile diarrhœa.

Not only may the products of the life of microbes be absorbed from the intestine, but the microbes themselves may enter into the blood. As a rule, microbes do not readily find entrance into the blood through an unbroken surface, whether it be of skin or mucous membrane, but they may do so readily when there is an abrasion present. When the microbes have entered the blood and are circulating with it through the various organs of the body, you can easily see that they are likely to exert actions of several kinds. Supposing, for example, that we inject into the blood-vessels of an animal a solution of sugar in which is living some yeast, which is one of the best-known microbes. You can easily understand that in doing so we inject first of all the yeast-plant itself, and this might have a mechanical action by plugging up the capillaries. Further, it is possible that the yeast-plant introduced into the blood might act upon such substances as glycogen in virtue of a ferment which it contains. This is almost entirely supposition, and I only bring it forward as an illustration. But, in addition to the yeast-plant, we should be injecting alcohol, which is the product of its life, and we should also inject some of the invertive ferment which it pours out into the fluid in which it lives. We would thus have (1) a mechanical action exerted by the cells of the yeast, we would have (2) a chemical poisonous action, that of the alcohol, and we would have also probably (3) a fermentative action from the ferment formed by the yeast and present in the injected fluid.

We have thus three different things to consider.

In the case of the yeast-plant, the blood and tissues would not afford a good soil for the growth of the plant, nor are the substances of which they are composed readily decomposed by it like the sugar in which it usually grows. But in the case of those microbes, which have the power of decomposing albuminous substances, things are very different.

When they enter the blood, there are probably three things to consider there also. There is (1) the mechanical action of the microbes in plugging up the capillaries, (2) there is the toxic action of the poisons which the microbes have produced, and (3) there is the action which these microbes may exert in virtue of any ferment which they may contain, or which they may excrete from their bodies. The same ferments which enabled them to live, to grow, and to form poisons outside the body in a proteid solution will enable them also to form poisons within the body from the albuminous substances they find there. But it is a curious fact that these microbes appear in the process of their growth not to form single poisons, but to form compounds of various kinds. I gave an illustration of the splitting up of albumin the other day, and mentioned to you that it might be split up in such a way as to form some products which would have a poisonous action and others which would not only have a non-poisonous action but a protective action. Now, in the case of the decomposition of fibrin by means of pepsin, you know that we get at least three or four different classes of products. We get albumoses and peptones, but these albumoses and these peptones are not all of one kind. They have been divided into hemi-albumoses and anti-albumoses, hemi-peptones and anti-peptones, and anti-albumid. All these different products taken together may be said to be formed from albumin by the addition of water, and if we could put those different substances again together with the subtraction of water, we might again form albumin. Now, albumin is not a poisonous body, but the products of its splitting up are poisonous. It would appear that some of these products which are poisonous when injected separately are not at all poisonous when injected together, so that the products of the life of the bacteria are partly poisonous and partly antidotal; partly they consist of toxins and partly of antitoxins.

I mentioned to you before that the processes of life are much the same in the highest and in the lowest animals, and also in plants, and perhaps it may assist your comprehension of the products of these bacilli, which belong to the lowest class of plants, if we take an example from some of the higher plants where the chemistry of the products of the life of the plant is better known. We will take jaborandi. The leaves of this plant contain an alkaloid—pilocarpine—which has a very marked action, stimulating all secretions, but it has also another alkaloid known as jaborine, which has just the opposite effect, inasmuch as it paralyses all secretions. As a rule, these two alkaloids are not equally balanced. In the jaborandi leaves you generally find that the pilocarpine is in excess, so that an infusion, or extract, or tincture of jaborandi will cause profuse secretion from the lachrymal glands, from the sweat glands, from the salivary glands, and even from the pancreas and the glands of the stomach and intestine, but it might so happen that in a particular specimen of jaborandi you might find these alkaloids equally balanced, so that, however much of the infusion or tincture of the drug you gave, it would have no apparent effect. If you were to treat the jaborandi leaves chemically and separate those alkaloids, you would then have it in your power, by giving a dose of jaborine, to counteract the effect of the pilocarpine in any given case; and what occurs in the jaborandi leaves appears also to occur in the case of the products of the life of microbes. They form certain substances which are toxins, and which we might compare with pilocarpine and other substances which are antidotal, and which we might compare with jaborine.

Struggle for Existence—Phagocytosis.—It would appear that some of those poisons which are excreted or formed by the microbes are of advantage to them in the struggle for existence. I have mentioned to you before that most of these microbes have a struggle with matter which is in a living condition, but they attack dead matter with comparative ease. If the microbes have the power of forming a poison which will first destroy any living cells the microbes themselves may thrive upon the cells thus destroyed. In the body a struggle for existence goes on between the cells of the organism and the microbes which invade it. To this struggle a great deal of importance has been attached, and it is termed "Phagocytosis." In my "Text-book of Pharmacology" I have reproduced some drawings by Metschnikoff, and at first sight one might be inclined to look upon them as being diagrammatic, but they are not so; they are really accurate representations of what occurs (Figs. 13—23). Professor Metschnikoff was kind enough on one occasion to give up two hours to me and to show me the whole process. It takes a good while to watch the process of phagocytosis, but in two hours the whole thing could be very readily seen.

In the daphne, or water-flea, the tissues are perfectly transparent. It is frequently attacked by a parasite consisting of spear-like rods. These enter the intestinal canal, they penetrate through it into the body-cavity, but almost as soon as one end of the rod has passed into the body-cavity it is attacked

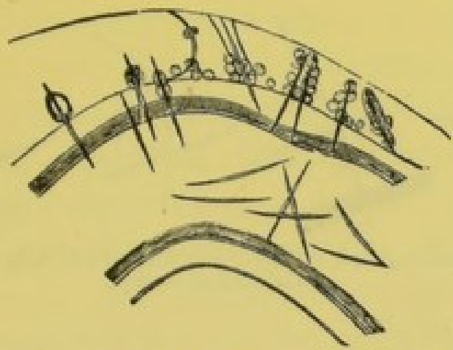

FIG. 13.—A piece of the anterior part of the body of a daphne, with a number of spores, some of which are still in the intestinal canal, others are penetrating the intestinal wall, and others are free in the abdominal cavity, where they are attacked by leucocytes.

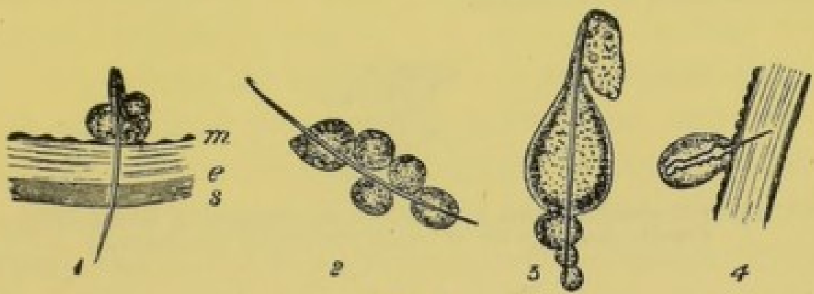

FIG. 14.

1. A spore which has penetrated the intestinal wall and entered the abdominal cavity, where four leucocytes have surrounded its end. *m*, the muscular layer of the intestine; *e*, epithelial layer; *s*, the serous layer.
2. A spore surrounded by leucocytes from the abdominal cavity of a daphne.
3. Confluent leucocytes enveloping a spore.
4. A spore of which one end is being digested by a leucocyte.

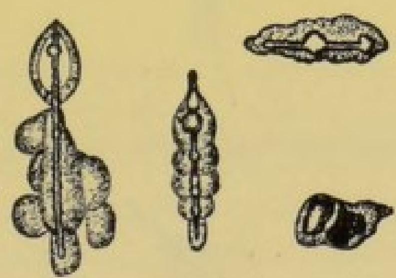

FIG. 15.—Different stages of the changes undergone by spores through the action of phagocytes.

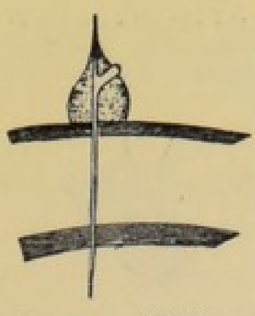

FIG. 16.—A germinating spore with leucocyte adherent to it.

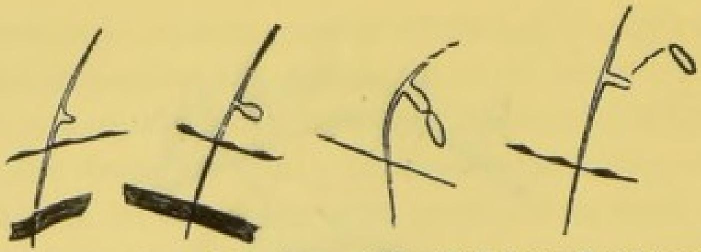

Fig. 17.—A spore germinating and forming conidia, which drop off and become free in the abdominal cavity.

a b

Fig. 18.—a and b, two stages in the process of leucocyte eating up two conidia.

Fig. 19.—A leucocyte enclosing conidia.

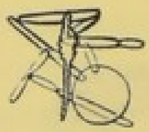

Fig. 20.—A group of conidia which have caused the leucocytes surrounding a spore to dissolve, leaving only an empty vesicle and fine detritus.

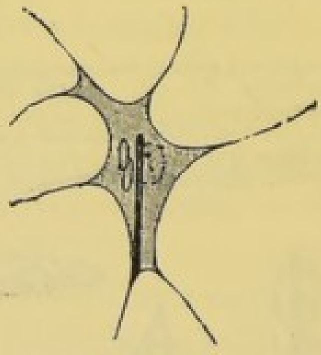

Fig. 21.—A connective-tissue phagocyte, containing three fungi-cells.

Fig. 22.—Leucocyte of a frog from the neighbourhood of a piece of the lung of a mouse infected with anthrax about 42 hours after the piece of lung had been placed under the skin of the frog's back. The leucocyte is in the act of eating up an anthrax bacillus.

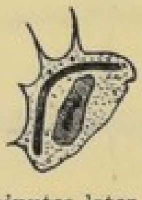

Fig. 23.—The same leucocyte, a few minutes later, after it has completely enveloped the bacillus.

by leucocytes. They settle down upon it, and frequently we find, after a while, that, instead of the outline of the rod being smooth, as it was when it passed through into the body-cavity, it becomes eroded, reminding one very much of an old nail that has been eaten away by rust, and if it is watched for a length of time it will break up entirely. Sometimes you may find single leucocytes just sticking on it, and sometimes they seem to agglomerate into a mass or plasmodium. Sometimes, apparently, the leucocytes are not sufficiently quick; then the rod appears to germinate, and these germs or conidia which form upon it remain attached to it for a while and then split off. The leucocytes frequently come down upon the conidia and attack them. Sometimes the leucocytes kill the conidia and eat them up, but sometimes the reverse takes place, and the conidia appear too powerful for the leucocytes. Then you find the leucocytes gradually become almost like empty bladders; they are destroyed, and then, the defenders of the organism having been disposed of, the parasites are free to germinate and increase, and the daphne is killed. There is a regular fight between the leucocytes and the microbes. The leucocytes appear unable to attack the parasites except by actual contact, but the conidia appear to secrete something which will kill the leucocytes at some little distance off.

The process of phagocytosis at one time seemed to be most important in regard to the production of immunity, but a great deal more importance is now being attached not so much to the actual attack of the leucocytes upon the parasitic intruders as to the products of the life, or even of the death, of the leucocytes; for leucocytes may secrete during their life, or may yield when they are broken up, substances which will have an antagonistic action to certain poisons.

In the case of one disease, viz., tetanus, the symptoms are apparently due to the powerful action, not so much of the microbes themselves, but rather of a poison which they form inside the organism. You all know that if a little wound be received between the finger and thumb, it may lead after several weeks to an attack of tetanus or lockjaw and the consequent death of the patient. This is due to the fact that certain bacilli have been introduced under the skin, and there they have grown, have multiplied, and have produced a poison. It would appear that the bacilli themselves have no mechanical action in plugging up the capillaries, nor are the symptoms due to a poison formed outside the body. They appear to possess a ferment which acts locally at the point of introduction and produces after a certain length of time a quantity of poison sufficient to kill the individual. This poison seems to be partly of an alkaloidal and partly of an albumose character, the albumose being more active than the alkaloids.

RESISTANCE.—The action of various other toxins has been investigated, and some of them present a striking analogy to snake venom in their action.

One curious point that is to be noted is that a toxin when injected into an animal in successive doses engenders a power of resistance to its action. If, for example, the toxin separated from the streptococcus pyogenes is injected into the blood, it produces a marked fall of temperature preceded by a rise. If one dose be given the effect upon respiration and upon circulation is well marked, but if more be given very little further action is to be observed upon respiration, pulse, or circulation. However, the power of resistance is limited, so that much poison acts on the blood and tissues, and the animal gradually sinks.

Now, we find that a similar power of producing resistance in the animal and so lessening the action of subsequent doses is possessed by various products of the tissues of a higher animal. For example, if we take extract of the thyroid gland and inject it in moderate quantity into the blood, it occasions almost instant coagulation, but if we take a small quantity of the extract insufficient to produce coagulation and then inject gradually increasing doses, the subsequent doses do not cause coagulation.

ACTION OF DRUGS ON THE BLOOD.—Coagulation of the blood has always been a question of great difficulty, and yet it is one of very great importance indeed, especially to surgeons and occasionally to physicians. You will be called upon almost certainly in the course of your practice to deal with cases of hæmorrhage, say from the stomach or from some other organ, where the patient is anæmic, and unless you can arrest the hæmorrhage the patient will surely die. Until the last two or three years we did not know how to render the blood more coagulable, and in cases of so-called bleeders operations were almost impossible. Thanks to the researches of Hammersten, Arthus and Pagés, Wright, and others, we now know how to increase coagulability. We know that if you precipitate all the calcium salts from blood you render it incoagulable. I have here some blood which was collected at the slaughter-house. The animal from which the blood was obtained was bled into a vessel containing a 1 per cent. solution of oxalate of sodium, the solution being present in the proportion of 1 vol. of it to 9 vols. of blood. As you see, the blood has not coagulated. A reaction has taken place between the added oxalate of sodium and the salts of calcium in the blood. As a result oxalate of calcium has been formed, which, being insoluble, has been precipitated. Thus the result of adding oxalate of sodium to the blood has been to deprive it of its soluble calcium salts, and this is why it has not coagulated. That this is the reason of the non-coagulation we know, because, if we add a small quantity of a soluble calcium salt to this liquid blood which we have treated with oxalate of sodium, it will rapidly coagulate. I have here three specimens: (1) some blood simply oxalated, which, as you see, remains liquid; (2) some oxalated blood to which a few drops of a 1 per cent. solution of calcium chloride were added a short time ago: this, as you see, has firmly coagulated, so that I can even invert the specimen without any running out; (3) and—this you will perhaps think a somewhat paradoxical result—some blood to which a few drops of a 10 per cent. solution of calcium chloride have been added: this blood, as you see, remains perfectly liquid. We see here another example of what I mentioned a few lectures ago, viz., that the action exerted by any substance depends very largely upon the dose. In this last case the anti-coagulating power of the calcium chloride, which was known to Hunter, is probably to be explained physically. All neutral salts, even when present in a moderate quantity, tend to hinder coagulation. The quantity of calcium chloride which we added to the oxalated blood in the third glass, although sufficient to replace the soluble calcium salts precipitated by the oxalate, was also sufficient to exert its action as a neutral salt, and thus hindered instead of accelerating coagulation.

Although one runs the risk in a test-tube of adding too much calcium chloride, I do not think there is very much chance of overdoing it in human beings. I do not think there is very much likelihood of their absorbing enough calcium chloride to overshoot the mark, and again render the blood less coagulable than before; so that in cases where you have got much bleeding you may give calcium chloride freely, either by the mouth or by the rectum. Other soluble salts of lime will do, and I very frequently, in cases of hæmorrhage from an ulcer of the stomach, give enemata of milk, containing the saccharated solution of lime. This answers apparently very well, but if the hæmorrhage should persist in spite of the use of the saccharated solution of lime, then you may give the calcium chloride. In one case, which was narrated to me by a surgeon, where it was necessary to remove a large portion of the skull-cap—in the case of a bleeder—I think as much as 40 grains of chloride of calcium were administered in a day, with the best possible results, the great tendency to hæmorrhage, which was previously present in the patient, being completely removed. The operation, therefore, was conducted without any risk, although, unless chloride of calcium had been given, the patient would almost certainly have died of uncontrollable hæmorrhage.

Oxidation.—The blood and tissues have another property, which is that of oxidation. The blood has the power of taking to itself oxygen, and forming oxyhæmoglobin. This compound between oxygen and hæmoglobin is of a very loose character, so that the oxygen from the oxyhæmoglobin is very readily given up to any reducing substance. Most of the tissues have a reducing power, and therefore during the passage of arterial blood through the capillaries the oxygen is withdrawn from the hæmoglobin. There are certain substances which tend to prevent the hæmoglobin from giving off oxygen thus readily, and to lock the oxygen more tightly up within it. The substances that have most practical interest in this respect are the nitrites of various sorts, and carbon monoxide. The nitrites form compounds with oxyhæmoglobin. In these the oxygen is locked up pretty firmly, so that they do not part with it readily like oxyhæmoglobin, yet they may be broken up, and the oxygen liberated by strongly reducing substances. Upon mixing blood with a little nitrite of amyl it becomes of a chocolate colour. This is due to the formation of a substance called methæmoglobin. The result of the substitution of methæmoglobin for oxyhæmoglobin is that an animal which has inhaled much nitrite may get dyspnœa, yet it does not run any very great risk of death, because as soon as the dyspnœa gets very bad, the tissues being very deficient in oxygen, their reducing power becomes so far increased that under its action methæmoglobin gets broken up, and hæmoglobin again formed. With nitrites, therefore, considerable dyspnœa may result, but, as a rule, it does not lead to any fatal consequences, the compound being broken up when the dyspnœa and the non-oxygenation of the tissues reaches a certain point.

This is not, however, the case with carbon monoxide, because the compound it forms with hæmoglobin is very stable, and is not readily decomposed, so that, once the hæmoglobin becomes saturated with carbon monoxide, it no longer undergoes the changes it ought; in passing through the tissues, it does not give off oxygen to them, and it does not take up oxygen in the lungs. Therefore, in the case of poisoning by carbon monoxide, artificial respiration is little or no use, because it is the blood, and not the respiratory apparatus which is in fault, and almost the only way to save the patient is to bleed him, transfuse fresh blood into his veins, and then keep up artificial respiration. By these means patients have been saved who would otherwise have been killed by carbon monoxide.

There is a third substance, viz., hydrocyanic acid, which seems to form a compound with hæmoglobin of considerable importance. I think, however, that its action is not so much upon the blood as upon the tissues themselves. I think it is not so much that the hydrocyanic acid prevents the blood from *giving off* oxygen as that it prevents the tissues from *taking up* oxygen.

Action of Drugs on Oxidation.—Many tissues, as well as blood, have the power of taking up oxygen and of passing it on. For example, if we mix a little tincture of guaiacum with water we shall not see much change, except that the guaiac resin will be precipitated in the form of an impalpable powder, which will seem of a light rose colour. Guaiac resin, when oxidised, becomes blue, and I daresay we shall be able to see that the addition of a little blood to some guaiac resin will render it blue. But, in the short time we can spare to look at it now, no oxidation appears to be taking place. There is no blue colour developed, because the blood does not take up oxygen from the air sufficiently quickly, but if we allow it to stand for a while, the blue colour will be seen. If we add to this mixture of guaiac resin water and blood, something that will readily give off oxygen, we shall find that, with the aid of the blood, a blue colour will develop. I add a little ozonic ether, which is a solution of hydrogen peroxide in ether, and we at once see the blue colour appear. In another test-tube I have mixed some guaiacum resin with ozonic ether alone, but we have not got the blue colour, the reason apparently being that the guaiac resin has not sufficient affinity for oxygen to take it up from the ozonic ether itself, but the blood takes up oxygen from the ozonic ether, and then passes it on to the guaiac resin. In this respect blood exerts an action like many ferments, only that ferments seem to pass on *water* rather than *oxygen*, so that their action is generally one of *hydrolysis* rather than *oxidation*. Other tissues besides blood, and, indeed, protoplasm generally, have the power of passing on oxygen in a similar way. I have here some potato which has been scraped, mixed with water, and passed through a sieve. You will find that this also has a power similar to that of the blood, but it will not act quite so quickly. Now I have added to the potato pulp and water, a little tincture of guaiacum, and some ozonic ether, and you see that oxidation is already beginning, and the mixture is turning blue. This oxidation is chiefly carried on by the living protoplasm, which in the potato is just under the skin. If we now cut a potato in half, and pour over the cut surface some tincture of guaiacum, we shall find that a blue colour will develop just under the skin, and that this will be very much brighter than any blue which may occur in the middle of the potato.

The power of oxidation possessed by protoplasm may be affected by various drugs, amongst which is hydrocyanic acid. Quinine also lessens this power of oxidation, and if we dissolve some quinine with a little acid, and then repeat our experiment, we shall find that there will be a considerable difference in the oxidising power of the protoplasm. If we take two portions of the potato, one with water alone and one with solution of quinine, and then add to each some tincture of guaiacum, and afterwards some ozonic ether, we shall, I think, probably find that even before the end of the hour there will be a distinct difference in the oxidation of the two, one being deep blue, and the other hardly blue at all. We also see a very marked difference in the evolution of oxygen, for it is given off in small bubbles from the mixture of protoplasm and hydrogen peroxide only, but not from that which has been acted upon by the quinine. It has been supposed that this action of quinine in lessening oxidation is the cause of its antipyretic action. We know that when quinine is given in large doses to animals or to persons suffering from a febrile condition it lowers temperature.

ANTIPYRETICS.—A rise of temperature is usually regarded as indicating fever, and drugs which lower temperature are known as antipyretics. To this class quinine belongs, and it is supposed that its power of lessening oxidation is the cause of its reducing the temperature in fever.

Besides lessening oxidation, quinine has the power of arresting or lessening protoplasmic movement. Movement is almost always due to oxidation, either in animals, plants, or machines. In our locomotives the energy which is expended in movement is supplied by the oxidation of the fuel by the air. The same is the case with the movements of plants, or the movements of animals. Arrest oxidation, and movement ceases. It has been supposed, then, that the power of quinine to lessen oxidation is in relationship to its power to lessen protoplasmic movements. This action has been observed, not only on simple organisms, such as amœba, but also upon leucocytes, and quinine will not only lessen the movements of free leucocytes crawling about the stage of a microscope, but will affect the movements of leucocytes within the blood-vessels. For this reason it has been supposed that quinine tends to arrest the formation of pus. I show you a drawing of a blood-vessel with a number of leucocytes, which, as you know, tend to stick along its walls and move out by a process of diapedesis (Fig. 24). If quinine be injected into the tissues around the

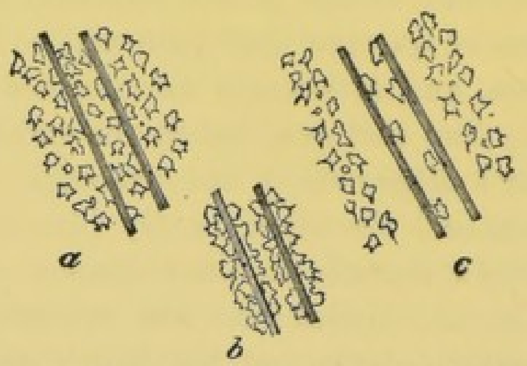

FIG. 24.—Diagram to illustrate the action of quinine on leucocytes, modified from Binz ("Das Wesen der Chininwirkung," Berlin, 1868). The thick lines represent the walls of the blood-vessel, and numerous leucocytes are shown both inside it and outside, distributed through the adjoining tissues. *a* represents the vessel before, and *b* after, the *local* application of quinine. The leucocytes outside the vessel have their movements arrested, and cannot wander on through the tissues, while those inside are not affected and continue to emigrate. *c* represents the effect of quinine injected into the circulation or lymph-sac. The leucocytes inside the vessel are here affected first, and their emigration stopped, while those outside still continue to travel onwards.

vessels, but not into the vessels themselves, it is found that the leucocytes tend to aggregate round the outside of the vessel; if, on the other hand, the quinine be injected into the vessel, the leucocytes are stopped from moving out, but the leucocytes that are already outside retain their power of movement, and so they go further on into the tissues. So that after a while you get two aggregations of leucocytes, one inside the blood-vessel and another at a certain distance outside, with a zone between where there are no leucocytes at all, those leucocytes which were outside having crawled onward, while those that were still inside have been unable to pass through the walls of the vessel and become massed inside. At one time this was looked upon as being a very important action of quinine, and it was supposed that this power to lessen the formation of pus was of great advantage to the organism. We are beginning now to look upon the formation of pus as not entirely disadvantageous, but rather as an indication of a useful reaction of the organism against the invading microbes. Formerly also we were inclined to regard fever as a thing of evil that ought to be abolished, but we are now inclined to look upon it as sometimes a useful reaction, and to consider cases of inflammation without fever as sometimes more serious than those where fever is markedly present.

ANTIPERIODICS.—The formation of pus appears to be the result of a fight between the leucocytes and the invading microbes, the leucocytes crowding to the point attacked in order to defend it (Figs. 23 and 14), and being killed by the invading microbes (Fig. 20), so as to resemble very much the swarm of dead bees that one sometimes finds round a hive when it has been invaded either by other bees from another hive or by wasps. In the fight many of the defending bees are killed, and their dead bodies are strewn in front of the hive. In like manner many of the defending leucocytes are killed in the struggle, and their dead bodies are found in pus.

Fever may also be regarded as a defensive arrangement. In some cases we know that the microbes which invade organisms are killed when the temperature rises to a certain height, and that the mere fact that a patient has had a pretty high fever may ensure him against a return of the fever. This we find to a considerable extent in cases of relapsing fever, where the spirillum, upon which the disease depends, is killed by the high temperature which occurs at certain periods of this disease. Till recently we knew little or nothing about the pathology of ague. It had been supposed to be due to an organism, but this organism was usually considered to be of a bacillary nature. Recent researches have shown that in all probability the poisonous agent in ague is more like an amœba, a kind of plasmodium, and that this invades the blood corpuscles and destroys them. The utility of quinine in arresting malarial fever or in putting a stop to the other manifestations of malaria, such as headache, neuralgia, and so on, is not due to its action upon leucocytes, but to its acting as a poison to the plasmodium.

As I have before mentioned to you, the quinine must be absorbed before administration. It is not readily absorbed if there is any congestion of the liver, and if you have, as you frequently will have, to deal with patients in the tropics, it is no use giving them quinine until you have unloaded the liver, if that organ should be enlarged and congested. In fact, as my friend Sir Joseph Fayrer has forcibly expressed it, you might just as well throw the quinine down the sink as administer it under such circumstances. Therefore in dealing with these cases of malarial fever, which many of you who go to India or other tropical countries will have to treat, always remember that the first thing you have to do is to unload the liver, give your patient a good purgative of calomel or blue pill, and follow this up with a brisk saline, and then give quinine.

It has been shown that, while one may often fail in treating ague with quinine alone, one may sometimes treat it successfully and cure the patient by means of emetics and purgatives, but the most efficient way is to give your purgative first and quinine afterwards.

There is another substance that has a powerful antiperiodic action, and that is arsenic. Arsenic is not so useful as quinine in cases of well-marked ague, but it is sometimes even more successful in the case of so-called "masked" malaria, where, instead of getting a well-marked rigor, you get recurrent neuralgias, headaches, or other affections. As an example of another kind of malarial symptom I may mention a case I have seen of diarrhœa where all the ordinary astringents failed to cure, but where quinine stopped the diarrhœa at once. This was the case of a man who lived in a malarial district, and where the diarrhœa no doubt depended upon the malarial poison.

Both quinine and arsenic may be used not only as curative measures, but to a certain extent as prophylactic measures, in cases where you have to deal, say with a lot of troops quartered in a malarial district. You may lessen your own labour and you may gradually increase the health of the troops by serving out quinine or arsenic as a prophylactic, putting the troops on regular doses of quinine or arsenic, not to cure them, but to prevent their getting ill. The doses, of course, vary a good deal with the men you are dealing with and with the nature of the fever, whether it is one of the very severe forms or not.

For the plasmodia on which malaria depends are of different kinds. There is a large one, which causes ordinary ague, and there is a small one, which tends to cause pernicious fevers, and in the cases where one is dealing with pernicious fevers one generally uses very much larger doses of quinine than in an ordinary case of ague.

LECTURE 6.

Inflammation—Pain—Effect of position—Cold and heat—Antiphlogistics —Fever—Antipyretics.

Gentlemen,

One of the objects of pharmacology is to try and simplify the action of medicines, and it is always a great comfort to us when we can find that two or three different results of a medicine are brought about from one common action. In the case of quinine, it has an action as an antiperiodic in curing intermittent fever, as an antiphlogistic in lessening inflammation, and as a febrifuge, or antipyretic, in lowering temperature. How far these different effects are connected together, one cannot yet positively say, but it seems by no means improbable that they all three may be to a great extent dependent upon the power of quinine to lessen protoplasmic movements. I have already told you that quinine has the power of lessening or entirely arresting the movements of leucocytes. The movements of those isolated cells are readily observed, but the movements of cells which are fixed are not so easily noticed. In certain cells, however, more especially the pigment cells in the skin of the frog, the movements of protoplasm may be followed, because the protoplasm is studded with a number of granules, by which an indication is afforded of the movements of the protoplasm itself. Changes have been noticed in the pigment cells of the frog during the process of inflammation.

Inflammation.—Inflammation, as the name implies, suggests an idea of burning, and the name has been given from one of the prominent symptoms; viz., the burning feeling in an inflamed part. The cardinal symptoms of inflammation used to be one of the stock questions at examinations. They are Rubor, Calor, Tumor, and Dolor. Redness, heat, swelling, and pain are the chief symptoms of inflammation. Now, what are the causes of these? The redness is undoubtedly due to dilatation of the vessels in the inflamed part, and more especially in

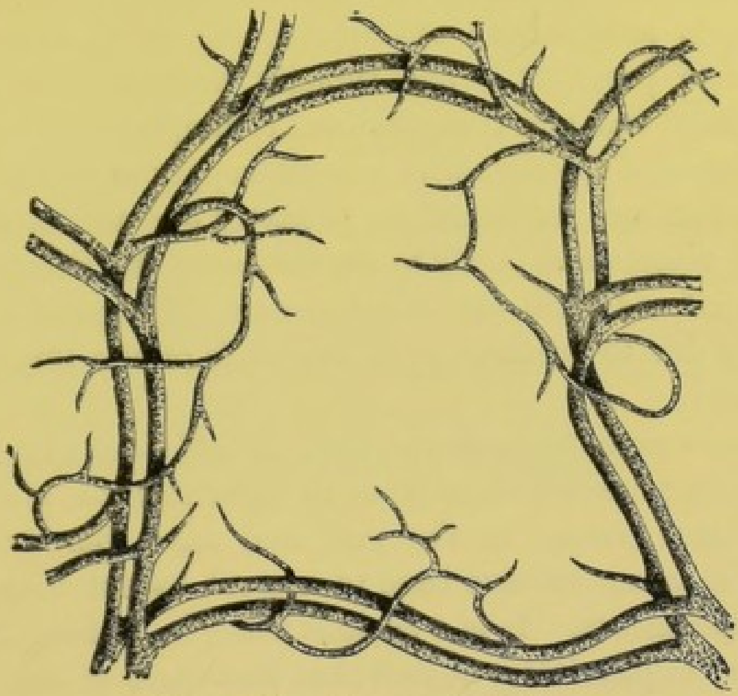

FIG. 25 —Vessels in normal condition.

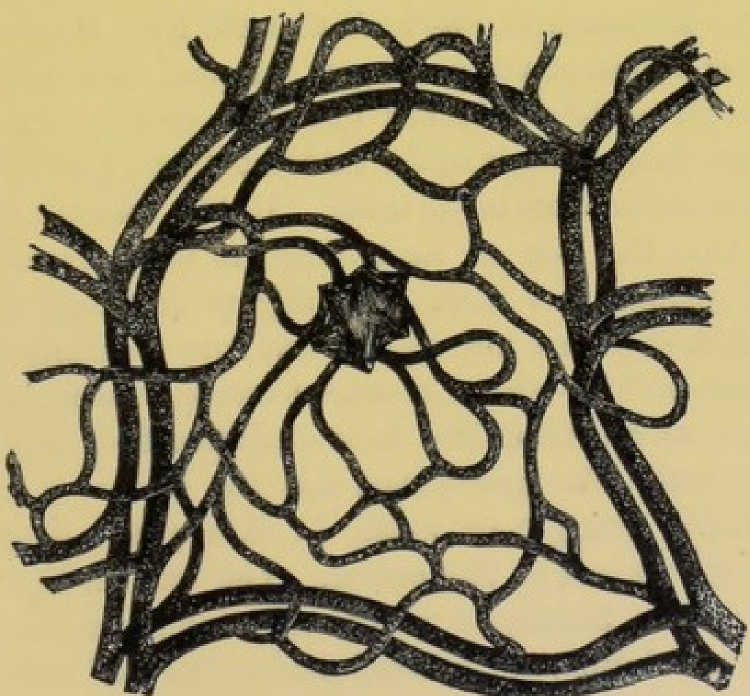

FIG. 26.—The same vessels after irritation.

the capillaries of the inflamed part; so that a larger amount of blood comes to pass through the capillaries, and, to a certain extent, it not only passes through, but stagnates in, them. Therefore stasis of the blood is one of the phenomena observed in inflammation. The heat of an inflamed part used to be said to be due to more active oxidation going on in the tissues of the inflamed part. It is now thought, however, that this idea is a mistaken one, and that the heat is simply due to dilatation of the vessels of the part with a freer supply of warm blood to it. The tumour, the swelling, is partly due to the fulness of the blood-vessels and partly to imbibition of the tissues by fluid which is effused from the blood-vessels. The pain appears to be chiefly due to pressure upon the ends of the inflamed part of the nerves.

It is quite possible, however, that the old idea that the heat, which is the prominent symptom in inflammation, is due to increased tissue change in the part, may have some truth in it, although it seems to have been to a great extent disproved by recent experiments. It is a curious thing in looking back over the history of physiology to find that ideas held at one time and disproved at another are again revived by more accurate observation. For example, one finds that the liver at one time was regarded as a most important organ. It was then pulled down from its high estate and looked upon as a useless organ, but at the present moment it is again reinstated and looked upon as an organ of the utmost importance. In like manner it is quite possible that the idea of heat being, to some extent, due to increased change, and more especially to increased oxidation, in the inflamed tissues may again come into prominence.

Oxidation in Cells.—Now, in order to see how such an increase may occur, we must consider how oxidation does take place in a healthy cell. The protoplasm has the power of absorbing oxygen, and of giving it off again. I show you a diagram of a cell with its nucleus in the centre. You can readily see that if such a cell be floating in a fluid containing a certain amount of oxygen in solution, the external part of the cell will get most oxygen, and will become, to a certain extent, more or less oxidised, whereas the internal part will have a reducing character, and will be ready to take up oxygen from the external layer and to become oxidised at the expense of the

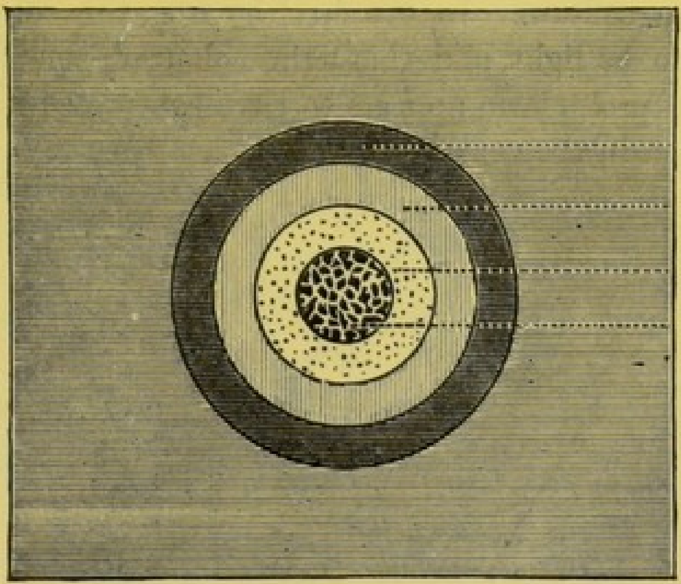

FIG. 27.—Diagram of a cell.

oxygen thus taken up. We shall thus have three layers. I mark the internal reducing layer in blue, and the external oxidised layer in red, while between them there is an intermediate layer which would be sometimes oxidised and sometimes reduced, according as the oxidising functions of the fluid which surrounds the cell, or the reducing functions of the internal layer, gained the upper hand. This intermediate layer must therefore be in a state of continual oscillation, sometimes acting as a reducing substance, sometimes as an oxidising substance.

You can readily see that if around this mass of protoplasm you are able to put a layer of more or less indifferent material which would stand between the external layer of the protoplasm and the fluid containing oxygen in which the cell is swimming, or in which it is embedded, the thickness of this layer would regulate the amount of oxygen passing from the external medium to the outer layer of the protoplasm. If this layer be thin, the protoplasm would come right up to the external medium containing the oxygen, and would thus become readily oxidised, but if this intermediate layer be thick, it will act as a barrier between the oxygen of the external medium and the protoplasm. Now, what is found in the pigment cells of the frog is this: they are very irregular in shape, and the movement of the protoplasm within them is observable by means of the granules they contain. In the healthy frog, the colour of the skin is apt to be light, and this light colour depends upon the fact that the protoplasm appears to have contracted until it forms a round ball in the centre of the cell.

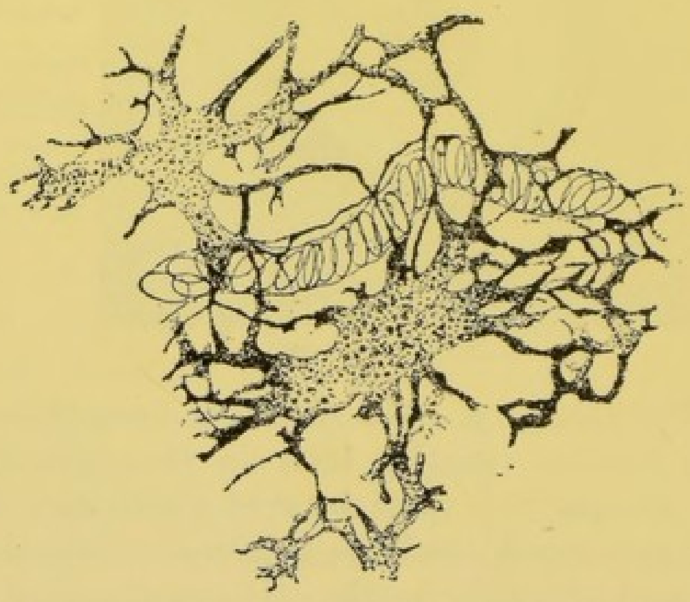

FIG. 28.—Two pigment cells from the skin of a frog with the pigment granules fully diffused and thus showing the full size of the cell, including both protoplasm and paraplasm. The protoplasm extends into the finest offshoots of the cell, and comes into contact with the fluid in which the cell is bathed. The bodies of the cells are pale, containing chiefly colourless fluid, while some of the finest offsets are quite black, in consequence of the dark molecules being closely packed together in them. In the same figure a capillary fully distended with blood corpuscles is also given. After Lister.

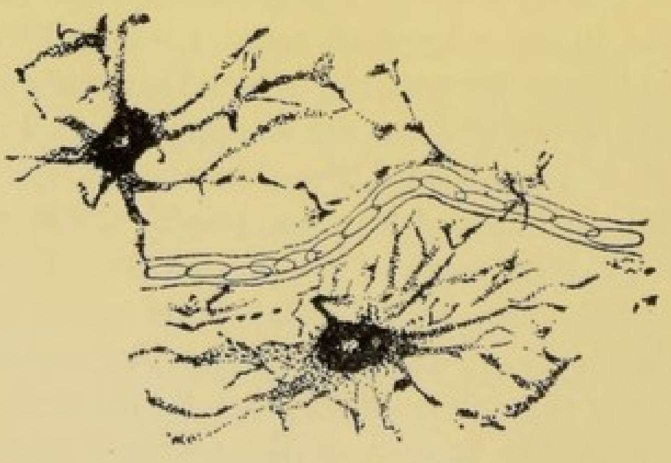

FIG. 29.—The colouring matter in the same cells as in Fig. 28 during the process of concentration. The dark molecules are already for the most part collected about the middle of the body of each cell, but in the very centre of each cell is a pale point, where the granules seem not yet to have insinuated themselves between the cell-wall and the nucleus. The same capillary is seen much reduced in calibre. After Lister.

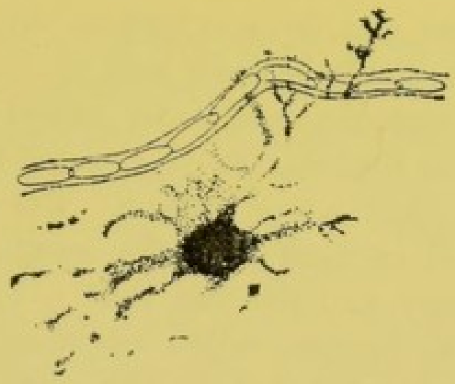

FIG. 30.—The process of concentration is seen to be almost absolutely completed, the molecules being almost all of them aggregated into a black circular mass, occupying the middle of the body of the cell, the more circumferential parts of which contain only a colourless fluid, and are therefore invisible. After Lister.

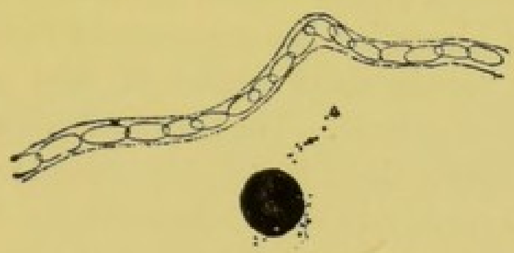

FIG. 31.—Shows the pigment in the lower of the two cells, concentration being still further advanced. By comparing this with Fig. 28 it will readily be seen what a large amount of paraplasm lies between the contracted protoplasm and the fluid bathing the exterior of the cell. After Lister.

Under the influence of irritating substances which induce inflammation, the protoplasm seems to extend itself right up to the walls of the cell, and thus you can easily see that oxidation from the lymph which surrounds the cell, and which is laden with oxygen derived from the blood, will take place more readily than it would do if the protoplasm were contracted. In the contracted condition there is a large amount of liquid—so-called paraplasm or cell juice—between the actual protoplasm and the cell-wall. During the process of inflammation the protoplasm will then undergo oxidation more easily, and more especially will this occur if a free supply of oxygen be given to the external medium by interchange from the blood to the lymph. And this is what occurs in inflammation, for the vessels of the part are dilated, a larger flow of blood takes place through the part, and so a larger supply of oxygen is brought to an inflamed part. We have thus in the inflamed part every facility for the oxidation of the protoplasm in the cells, and for the supply of more and more oxygen as the oxygen contained in the juices of the tissue becomes used up.

Now this phenomenon used to be looked upon simply as a morbid process, one that was to be arrested by every means in the power of the physician or surgeon. But it ought not to be regarded as an evil in itself, it is the reaction of an organism against some injury, and the fact that it is really a beneficial reaction was shown by some rather ingenious experiments made by Samuel. You know that if the fifth nerve be cut, there is a tendency for the cornea of an animal to become ulcerated, but if you cut the sympathetic nerve and thus destroy the vaso-motor supply to the vessels of the cornea, the cornea does not become ulcerated, and if ulceration has commenced from division of the fifth nerve, the cornea again begins to heal after subsequent division of the sympathetic. The reason of this appears to be that when the fifth nerve alone is cut, the dilatation of the vessels, which we see so readily in the conjunctiva on the application of any irritant to the eye, does not take place: therefore no extra supplies of oxygen and nutriment are brought to the injured cells; they consequently die, and ulceration of the cornea takes place. But if by dividing the sympathetic, and thus causing a permanent dilatation of the vessels of the eye, we get an increased supply of blood, bringing with it oxygen and nutriment, the cells remain alive, and no ulceration occurs.

Blisters.—When inflammation has lasted a long time the tissues become thickened, but the circulation is lessened, and the power of repair therefore diminished. In such conditions the application of a blister to the part re-establishes an increased circulation, repair goes on rapidly, and the healthy condition is restored. This is well seen in cases of callous ulcers in the leg, which may remain for years unhealed if left alone, but quickly heal up after the application of a blister.

Regulation of Inflammation.—But, like many other processes that are useful to life, the process of inflammation may be carried too far. It is a good thing for a man to eat a dinner, but if he eats too many dinners, and too much at each time, the process becomes injurious to the organism, and wants regulation. The same is the case with the process of inflammation. Though useful in itself, it sometimes needs to be regulated, but the regulation of it is one that requires a great deal of judgment on the part of the physician or surgeon. We find, however, that in many cases we can lessen the inflammation and relieve our patient, while at the same time we do not interfere with the processes of repair, in which inflammation is an important factor. One of the symptoms that our patients wish most of all to have removed is that of pain. Now the pain of inflammation, as I have mentioned, is, to a great extent, due to pressure upon the ends of the sensory nerves by the swollen tissues, and we find it most noticeable in cases where the swelling is confined, so that the tissues cannot swell without pressing very much upon the nerves. Thus we see that the pain is particularly intense if it occurs from inflammation in a bone or in a closed cavity, such as the alveolus of a tooth, or under an unyielding fascia or ligament, such as that of a joint in gout or rheumatism. When inflammation occurs in the alveolus of a tooth, as you well know, the pain becomes most intense, and when pus forms at the lower end of the fang of a tooth, one suffers very greatly until the pus has made an exit from the alveolus, either along the side of the fang, or, what is more common, by breaking through the side of the alveolus. The very moment that the pus has found an exit, and the pressure upon the ends of the nerves is removed, we find that pain is relieved.

Effect of Position.—But we can relieve pain sometimes merely by position. If any of you have had inflammation in one of your fingers, either through a splinter of wood running up under the nail, or from some other irritant, you know that if you allow the hand to hang down, the pain becomes very great, whereas if you simply raise the hand up to the level of the shoulder by putting a sling under the elbow, the pain is generally relieved to a great extent, although not completely removed. The reason of this simply is that when the hands hang down there is a very considerable increased pressure in the vessels, both in the arteries and in the veins, and so the terminal branches of the sensory nerves are subjected to greater pressure than before, and the condition approximates in some measure to the condition that you find in the alveolus of a tooth in toothache.

Cold.—We can also remove the pressure in another way: we can do it by applying cold to the part. We may put the hand in cold water, and the burning pain of the inflammation will be relieved. Instead of putting the hand itself into the cold water, you may put a cold compress over the arm, and the effect of this is to contract the efferent vessels. The cold contracts the arteries as they pass down to the hand, and you lessen the supply of blood to the hand. You will thus again diminish the pressure upon the nerves and ease the pain. For example, if you take a tracing of the radial pulse without the application of any cold compress to the arm you will get a

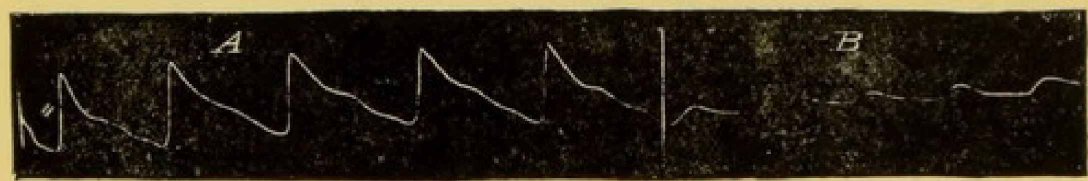

FIG. 32.—Tracings from the radial artery at the wrist, A before and B after the application of a cloth dipped in cold water round the arm. After Winternitz.

tracing such as I show in the drawing (Fig. 32). The artery throbs freely. Apply a cold water compress over the course of the brachial artery, and the throbbing in the radial artery will become very considerably diminished, and the pulse will appear small as in the drawing. So that the application of cold to the inflamed part itself, or to a part of the body above the inflamed part—that is, between the heart and the inflamed part—may lessen the pain in inflammation.

It seems odd, though, that one of the commonest ways of relieving inflammation is not to apply cold, but to apply heat. This reminds one of the old story in Æsop's "Fables" of the traveller who went one day into a wood and got lost. At night he met, while wandering about the wood, one of those mythical denizens of the wood, the satyrs, who invited him to go to a cave and have some refreshment. This satyr provided some soup; but the soup was cold, and required to be boiled. The fire did not burn well, and the traveller went down upon his knees and blew into the fire. "What are you doing that for?" said the satyr. The traveller replied, "I am blowing the fire in order to make the soup hot." After the soup was heated, each had a plateful; but the soup by this time was rather too hot, so the traveller blew upon it. "What are you doing that for?" said the satyr. "I am blowing upon the soup to cool it," said the traveller. "Oh," said the satyr, "you blow hot, and you blow cold; get out," and the traveller was turned out accordingly. Now, we seem to be doing very much the same by applying heat and cold to the inflamed parts. Yet there was very good reason for the traveller's action, and there is very good and sufficient reason for our action, because by the proper application of heat and of cold we get the same result, namely, lessened pressure upon the peripheral nerves and diminution of the pain. Here is a diagram of a finger showing the artery

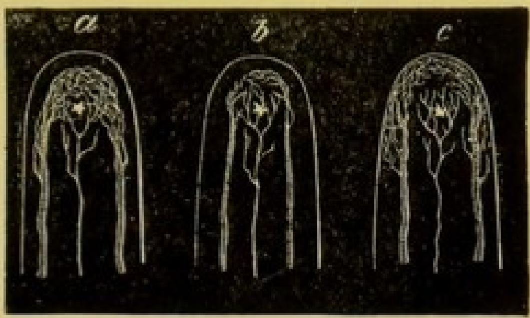

FIG. 33.—Diagram to show the effects of heat and cold in lessening the pain of inflammation. The diagram is supposed to represent the end of the finger. The small star indicates the point of irritation, *e.g.*, a prick by a thorn. The line in the centre of each figure is intended to represent the nerve going to the injured part; and at the side of each figure is an artery and vein connected by a capillary network. In *a* the capillary network around the seat of irritation is seen to be much congested; the nerve filaments are thus pressed upon, and pain is occasioned. *b* represents the condition of the finger after the application of cold to the arm or hand. In consequence of the contraction of the afferent arteries the finger becomes anæmic; no pressure is exerted on the nervous filaments, and pain is alleviated. *c* represents the finger after it has been encased in a warm poultice; the capillary network at the surface of the finger is dilated, and the blood is thus drawn away from the seat of irritation, and the pain therefore relieved.

breaking into a number of capillaries, with the veins and terminations of the sensory nerves (Fig. 33). These nerves will be pressed upon by the tissues themselves and by the dilated vessels, both arteries and veins, the finger being prevented from swelling much by the tough skin, but the pressure will be very much greater and the pain very much worse if the inflammation be under fibrous structures which will not yield at all, as in the case of a whitlow.

Now, you can readily see that you can lessen the pressure upon the nerves either by applying cold and so contracting the artery that less blood passes into the inflamed part, and less blood passes away from it, or by lessening the pressure within the vessels by holding up the hand if the finger be inflamed or raising the foot in a gouty patient. But you may lessen pressure on the ends of the nerves in another way, not by diminishing the quantity of blood going to the part, nor yet by lessening the pressure in the vessels by position, but by making the circulation through the part freer than before. That is to say, in the case of a whitlow, if you dilate all the capillaries in the outside of the finger, a lot of the blood, instead of going to compress the ends of the nerves in the centre of the finger, will pass through the more external parts, and you will have a larger bed for the blood stream than before, so that the pressure within the vessels will be considerably diminished. And so we find that one of the commonest ways of relieving pain is to put on a hot poultice, although sometimes we may apply cold instead.

One typical example of the use of equalising the circulation is in severe burns or scalds. Shortly before I was in Vienna, many years ago, a most unfortunate accident occurred. The daughter of one of the archdukes was fond of cigarette-smoking. Her father had a great objection to it, and one day this poor lady was smoking a cigarette when her father came into the room. She had a light muslin dress on, and just as her father came in she took the cigarette from her mouth and held it in her hand behind her, so that her father might not see it. The lighted end of the cigarette set fire to her dress, and she was most awfully burned, so that she died a few days afterwards. But the pain, which would ordinarily have been most intense, was in her case greatly relieved by simply putting her into a bath at about the temperature of the body and keeping her there all the time. The pain she suffered was, I believe, very slight, although she died from the shock.

Cold.—We have various ways of applying cold. For example, we can put on cold simply by the action of an evaporating lotion, and in cases of headache we frequently use this to relieve pain. If any of you have suffered from headache you probably know that you can often relieve the pain completely by simply compressing the carotid; but it is almost impossible to compress the carotid without exerting pressure at the same time upon the vagus, and before you have had your finger upon the carotid for more than a couple of minutes at the outside, although the pain in the head is relieved, the oppression in the chest, due to irritation of the vagus, becomes so great as to be unendurable. You are obliged to take your finger away and allow the blood to stream back to the head again, even although it causes intense pain, because the pain is more easily borne than the awful oppression which irritation of the vagus produces. But you will see that people who suffer from headaches very commonly take a handkerchief, wet it with water, and put it over the forehead. In place of using pure water, they frequently use water with a little vinegar in it. I do not know that there is any very special advantage in this except that the vinegar somehow has what we term a cooling action, though the exact *modus operandi* of it I cannot tell you. In place of simply putting the wet rag over the forehead, many people use eau de cologne, which they sponge over the forehead, and find that by the evaporation of the eau de cologne a good deal of cold is produced, and the pain in the head is much relieved. The effect of the eau de cologne is greatly increased by fanning the head, so that evaporation takes place more quickly. Where the pain is situated in the deeper structures rather than the scalp, as in cases of fever or meningitis, we apply cold to the head either by an ice-bag which is placed in contact with the head, or by the continuous passage of a stream of cold water through a cap made of coils of indiarubber tubing sewn together. This cap is simply placed upon the head, and one of the ends of the tube is connected with the reservoir containing iced water; the other end is thrown down into a basin below, so that the water which passes through the cap may be caught, and not flow over the floor. This same system of tubing may be adapted to any part of the body, and there are flat tubes which may be placed over the chest in cases of pleurisy or pneumonia, or over the abdomen in cases of peritonitis; but as a rule the ice-cap, as it is called, is more frequently used than the others.

For the local application of heat, we sometimes use simply a wet compress, which may be either cold or hot. If the compress be made with lint and gutta-percha tissue it soon becomes warm, even although it is cold to begin with, the evaporation being prevented by the gutta-percha tissue or oil silk. In the example that I have just given you, where we relieve pain in the head by means of a piece of rag or a handkerchief wetted with water, or water and vinegar or alcohol, we have free evaporation, and so the rag remains cold; but if you prevent evaporation by putting over the wet rag a piece of gutta-percha tissue or of oil silk, the rag very soon becomes quite warm: it reaches the temperature of the body and remains at that, so that it has nearly the same action as a poultice. You will very frequently find that in cases of inflammation of the finger, instead of applying a poultice, which requires to be often renewed, people apply a compress of lint and gutta-percha tissue, using at the same time the aid afforded by sustaining the elbow in a sling. In cases of sore throat the wet compress is very useful, and as sore throats are just now so very common, it may be worth while for you to see how the application is made. You take a bit of lint long enough to go round the throat, and it may either be made single, or twice as wide and doubled. Then, having put that round the throat, you cut a bit of gutta-percha tissue, which ought to be both a little longer and a little wider, so as to leave a margin of at least a quarter of an inch, in order that evaporation may be thoroughly prevented. You dip the lint into the water, squeeze it out, and then apply it to the throat, cover it with the gutta-percha tissue, and over all put another bit of lint, which should be as broad as the gutta-percha tissue, and is also best doubled. There are various ways of fastening this, but I think the best plan is to fasten it simply with a safety pin. This compress on the throat at night is useful for sore throats or for coughs dependent upon irritation of the pharynx, larynx, or trachea.

Heat.—A very useful means of applying heat is an india-rubber bag, which you fill with hot water, and this is very convenient for patients who are on a journey. Many of you may possibly get appointments requiring you to take invalids to the Riviera or some other health resort for delicate people, and in travelling, say with consumptive patients, they are very apt during the long journey to get pain somewhere. This may be in their chests, from a commencing attack of pleurisy, or it may be in their stomachs, from indigestion or flatulence, or it may be in their intestines, from the same causes as in the stomach, or it may be due to commencing diarrhœa of tubercular origin. In a long journey, such as that between Paris and Marseilles, the patient may suffer a good deal of pain unless you know what to do with him. The plan to follow is this: you take a bag, such as I show you, in the carriage, and then if your patient begins to complain of pain you get out at the next station, run along to the engine-driver, give him half a franc, and tell him to fill the bag with hot water, which he does at once from a little tap in the locomotive. Then you carry the bag back and put it on to the patient's side or stomach, and very often relief results, whereas, without your knowing about this little plan, he might go on suffering for hours from pain, and he might possibly become so bad that a dose of morphia would be necessary, either by the mouth or hypodermically. For pain in the stomach the bag is often very useful, because it can be so readily applied without even undoing the clothes, but it is not then quite so efficacious as a large poultice. Poultices are almost always of use where there is pain, and you may with advantage connect in your mind the two *p*'s: "pain" and "poultice." Relief is not always afforded by a poultice, but you can readily see why. Suppose you have inflammation in the alveolus of a tooth, and you apply a big poultice over the cheek, and especially if you get it down over the neck, the patient at once says: "I cannot bear this; it makes the pain ten times worse than before," quite naturally, because there is no room for the vessels to dilate without pressure upon the nerves. Perhaps you will better understand this by the diagram which I draw showing the alveolus, as if there were a space between the tooth and the bone with vessels and nerves ramifying in it. You can easily see that you cannot readily draw away much blood from these vascular branches in the alveolus by the application of a poultice to the cheek in the same way that you would in the case of a finger. What you would probably do is this: you would dilate the facial artery by the application of heat to the cheek so much that you would greatly increase the pressure in the alveolus and make the pain a great deal worse than before. In the case of formation of pus under the fascia lata of the thigh you find exactly the same thing, and a great many patients cannot stand the poultice because it greatly increases the pain, whereas in alveolar abscess if you apply cold to the cheek you may cause the afferent artery of the tooth to contract, and thus you get diminution of pressure and relief of pain. People suffering from toothache often employ cold applications, and they usually put them on over the part where the pain is felt, not knowing any better; but if they were to apply the cold a little lower down, so as to affect the carotid trunk, they would get a good deal more relief than by simply putting it over the cheek.

Poultices are made for two different purposes. You use poultices as a local application to sores, and you will find that in the wards here, for the sake of cheapness, the poultices are usually made by mixing crushed linseed with hot water and spreading it upon tow. The poultice thus made is applied directly to the part where we wish the heat to be employed. There is, however, this great disadvantage in using a poultice of this kind, that you are on the horns of a dilemma. You must either wait till the poultice is half cold, or else scald your patient. Now, in order to avoid this difficulty, it is much better if you are applying the poultice, not for its local action upon the skin or the parts below it, but for its action upon deep-seated tissues, to employ a poultice with something between the crushed linseed and the skin. If you do this in the case of a wound you do not get the soothing action which the mucilaginous and fatty ingredients of the linseed have upon the cut or broken surface, but where you simply employ the poultice as a means of applying heat, as, for example, in spasmodic and painful affections of the abdomen, the best way is to use a poultice-bag. This bag is made by taking a piece of flannel folded up so that the edges of the two folds do not come quite equal, but one fold projects beyond the other (Fig. 34). You

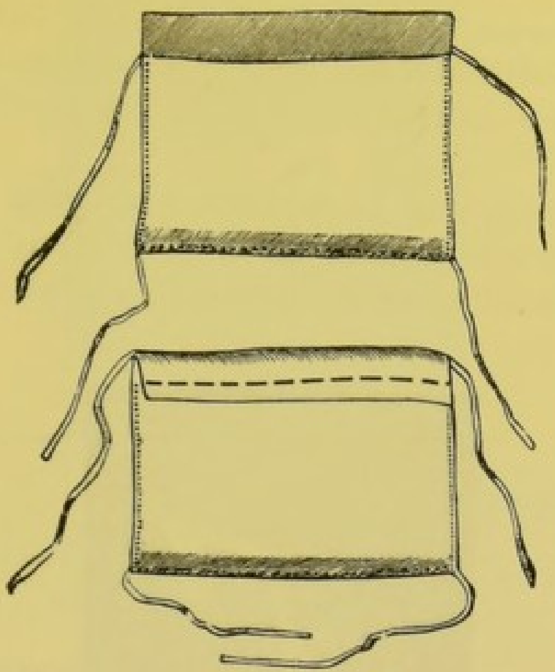

FIG. 34.—The upper figure represents the bag empty, the lower one the bag filled and sewn up.

then sew up the sides of the bag, leaving the end open, but with a flap, which may be turned over. I show you a bag ready made. Then make your poultice, taking care that it is very hot indeed. First of all warm the bowl in which you are going to mix the hot water and linseed, warm the spoon, and have the water for the poultice perfectly boiling. Make the poultice rather thinner than you think is necessary, because it thickens somewhat as it stands. Then put it into the bag, fold the flap down, and fasten it by a few loose stitches to prevent it opening out. Then take another bit of flannel, either single or double, roll the poultice-bag in this, and cover the whole of it up with the flannel; and in this way you can put on a poultice boiling hot without scalding your patient. The heat comes slowly through the flannel, and as it comes through it seems to relieve spasmodic pain in a way that other things do not. I remember very well a number of years ago one of my colleagues at this hospital was suffering from such intense abdominal pain that it seemed at first that he was having an attack of peritonitis. I went to see him and asked him if he had had poultices. He said, "I have had them on till I am tired of them." I said, "Will you let me try and make one?" He said, "You can do what you like." He was feeling so much pain that he really did not care what was done to him. I made a poultice in the way I have described, and he got relief.

Counter-irritants.—It is probable that when we apply a blister to the side in pleurisy or pneumonia we, sometimes at least, cause contraction of the vessels in the pleura and lung,

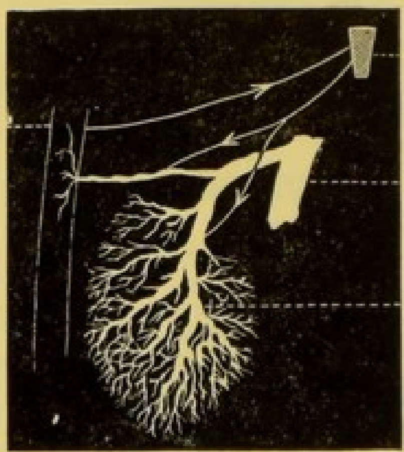

FIG. 35.—Diagram to show congestion of the lung. The pulmonary vessels are shown dilated, and those of the thoracic wall contracted.

and thus relieve pain in much the same way as when we elevate an inflamed finger. It has been supposed that a poultice or blister simply draws away blood from the inflamed part. We have seen that the poultice does this in the case of an inflamed finger, but in an inflamed lung or pleura the quantity which comes to the skin is insufficient to explain the relief. It is quite possible, however, that the vessels in the lung and pleura adjoining the inflamed district may be dilated by the application of a poultice or blister to the side, and thus relief is afforded in the same way as by the application of a poultice to the finger. It is not easy to say in which of these ways a poultice or blister acts in any particular case. Clinical experience seems to show that sometimes blisters relieve acute inflammation by causing contraction of the afferent vessels (as represented in the accompanying diagram, Fig. 36) and thus lessening the tension in the vessels of the inflamed part. If the blister is too near to the inflamed part, it may increase

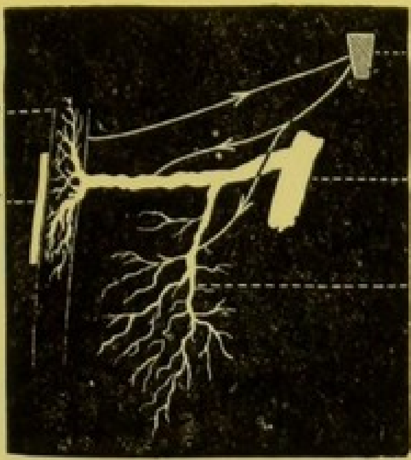

FIG. 36.—Diagram to explain the action of counter-irritation. A blister or other counter-irritant is shown applied to the chest-wall. The stimulus which it causes is transmitted up the afferent nerves to the vaso-motor centre; it is thence reflected down the vaso-motor nerves to the pulmonary vessels, causing them to contract, while it is reflected down vaso-dilating fibres to the vessels of the thoracic wall and probably of other parts of the body also, causing them to dilate and thus lessening the pulmonary congestion by withdrawing blood from the lungs. (Compare with Fig. 35.)

instead of diminishing the congestion, and thus do harm instead of good.

As a matter of practice, the rule is usually insisted upon that in a case of pericarditis, for instance, the blister should not be put immediately over the pericardium, but at some little distance from it.

Counter-irritation is not only used, however, as a means of lessening congestion and pain in acute inflammation: it is also employed with much advantage to cause the re-absorption of inflammatory products. As I have already said, the increased circulation which a blister causes in a chronic ulcer is most useful, and the rapid absorption of the thickened margins of the ulcer is perceptible to the eye. A similar absorption appears to occur in deeper-seated organs, such as the lung, on the application of counter-irritation to the chest, and painting with iodine liniment is useful in promoting absorption of liquid effused into the pleural cavity or of the product of chronic inflammation of the lung. The mode in which the irritation acts is probably the same both in the chronic ulcer and in the lung, *i.e.*, by increasing the circulation through the part affected. Where the blister is applied, as in acute pericarditis, to lessen congestion, it is usually placed at a little distance from the inflamed part, but where we wish to increase absorption, as in

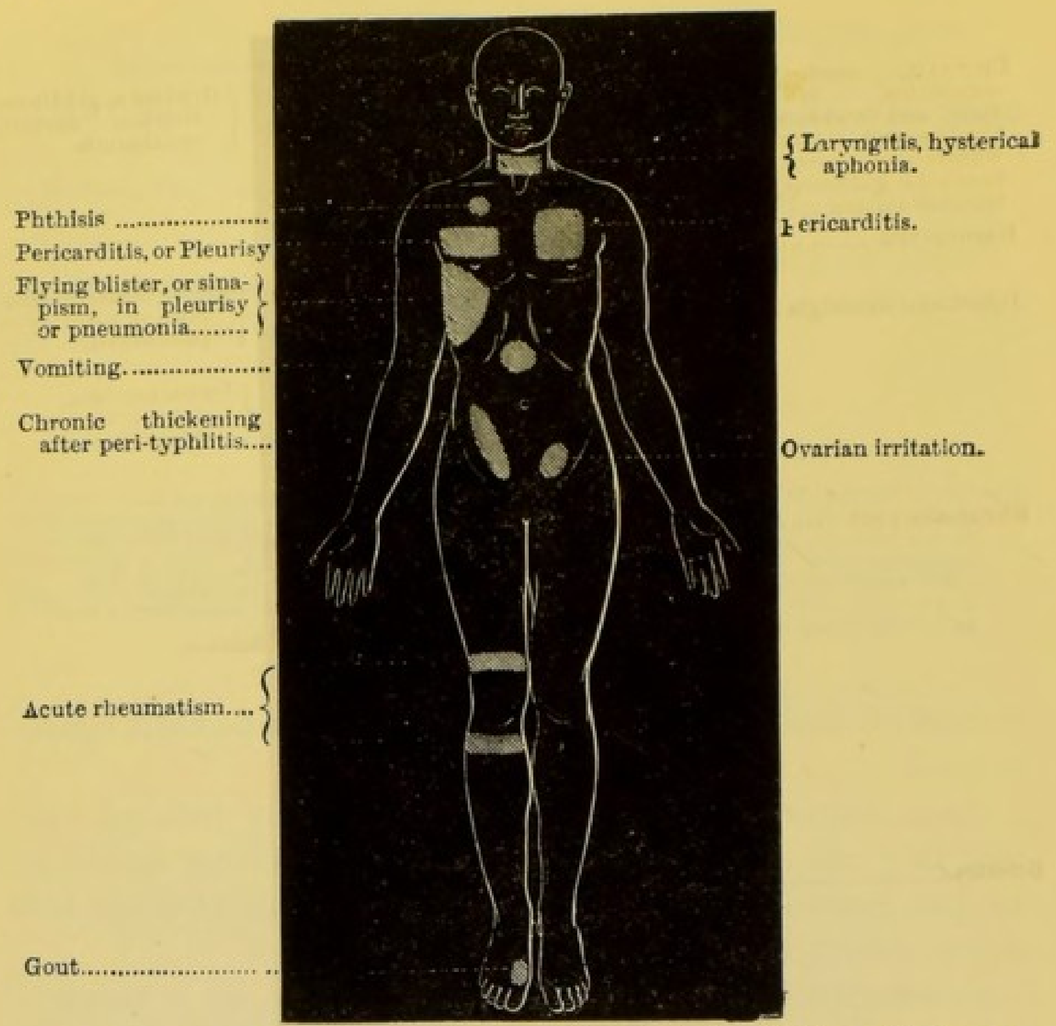

FIG. 37.—Diagram of the body showing some of the points where blisters or sinapisms are usually applied. Front view.

consolidation of a part of the lung, we apply the counter-irritant directly over the consolidated part.

Antiphlogistics.—We are able to regulate the process of inflammation by drugs also, and to the drugs which lessen inflammation the term "Antiphlogistics" has been applied. First of all, we have drugs which seem to act upon tissue change, and the most important of these, perhaps, is quinine. But along with quinine may be reckoned a number of new products of chemical industry, such as antipyrin, antifebrin, and the like. We have other antiphlogistics which lessen inflammation by acting upon the vessels themselves. Amongst the most important of these is aconite, and this appears to diminish the blood pressure and to relieve the pain partly by slowing the pulse.

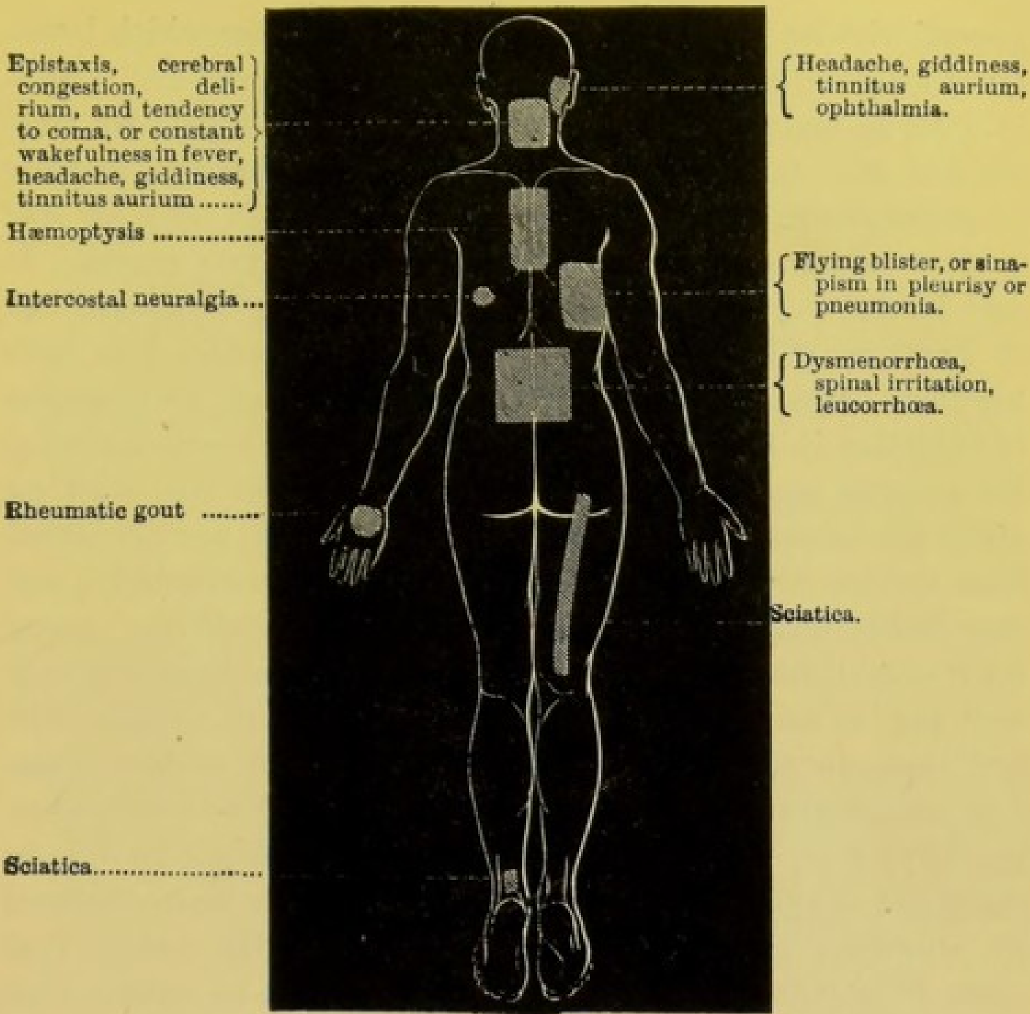

FIG. 38.—Diagram, like Fig. 37. Back view.

Aconite, which we shall have to consider more fully under the head of the action of drugs upon the heart, is an important substance, because in exceedingly minute doses it has the power of slowing the heart to a very great extent. This power is, I think, more marked when small doses frequently repeated are used than when large doses are employed at once, but I am bound to say that some of the large doses of aconite will relieve pain. The way in which it is usually given is one drop of the tincture which may be repeated every hour or every half-hour until the effect desired is brought about. The large doses consist of 10 minims at once, and I have seen pain relieved thus when small doses had no beneficial effect.

FEVER—*Antipyretics.*—Inflammation rarely lasts long without there being a rise of temperature in the body, and to such general rise we give the name "fever." To drugs which lessen fever we give the name "Febrifuges" or "Antipyretics." Now, in order to understand the action of these substances, we must consider how fever comes about. In fever we have an increase of temperature of the body generally, and this may be due to two causes, or to a combination of these two causes. It may be due to (1) increased formation of heat, (2) lessened loss of heat, or (3) increased formation and lessened loss both together. Heat is formed generally in the body by processes of oxidation in the muscles or in the glands, the muscles being the greatest source of heat. So long as people are walking about the temperature does not fall, but if they are prevented from moving the temperature tends to fall considerably, and they feel bitterly cold. There seems to be a provision of nature for re-establishing the temperature, and this condition was very well put to me by the late Surveyor-General of Canada, who had been, in some of his expeditions, exposed to very great cold, sometimes as much as 40° below zero. He said that when this happened "he shivered himself warm." While he was in camp and unable to move about sufficiently to warm himself by voluntary exercise the involuntary muscular actions that occur in shivering began and went on to such an extent that it restored warmth to his body. Now, we find that in muscular exercise we not only get an increased production of heat, but we get a quickened circulation whereby the heat thus generated is conveyed readily throughout the whole body, and so, instead of the muscle becoming, as we might say, red-hot from its own contraction in the same way that a blacksmith may hammer a piece of iron red-hot, the muscle is cooled down by the increased supply of blood, while at the same time the body generally is made warm (Fig. 39). Now, what happens with a muscle also happens with glands, and when glands begin to secrete not only does increased oxidation take place within them, but the vessels of the glands dilate, and these carry away to the rest of the body the heat that is generated in the glands.

Years ago I made a journey through the west of Scotland, and one day I rode on the top of a coach from Oban to Tyndrum

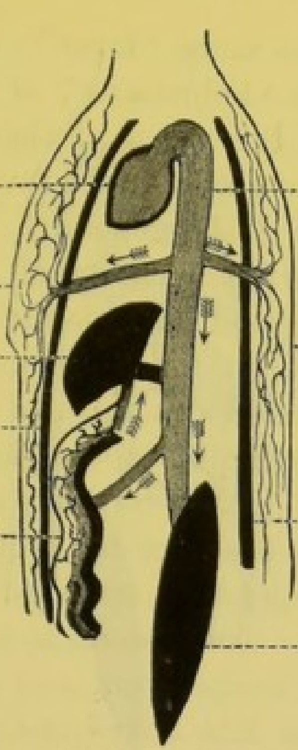

FIG. 39.—Diagram to illustrate the action of alterations in the circulation of the surface of the body and the internal organs and muscles upon temperature. In this figure the superficial vessels are represented as contracted, and there is therefore not only less loss of heat, but, the blood being driven to the internal organs and muscles, the circulation in them is increased, and the production of heat augmented. The parts where heat is produced are the dark, the darkness being in proportion to the greater production. The parts where heat is retained without much being formed, *e.g.*, the blood, are moderately shaded; those where heat is lost are left white. In the intestine heat is both formed and lost, and so the intestines are partly dark and partly light.

and then on to Loch Lomond, a drive of about 60 miles. It was a raw day and raining heavily, so that, in spite of a thick cloak, I felt miserably cold. The coach stopped, and we had dinner, and after that meal I began to feel very much more comfortable and, indeed, became quite warm. I did not know anything about physiology then, and I was sorely puzzled to understand why merely putting a lot of food into the stomach should make one so much warmer, but you can readily see how it occurred. By putting into the stomach food which also passed on into the intestine, the glands both in the stomach and intestine had become functionally active; heat was produced in them, and this heat was carried by the blood which poured through the dilated vessels of the glands to the rest of the body, and thus it was warmed.

But there is not only a power of regulating the production of heat in the body: there is a power of regulating the loss of

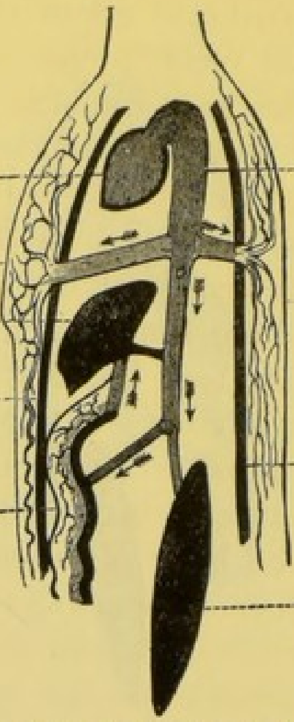

FIG. 40.—Diagram to illustrate the action of alterations in the circulation of the surface of the body and the internal organs and muscles upon the temperature. In the diagram the cutaneous vessels are represented as dilated, and thus not only is more heat lost from the surface, but, blood being withdrawn from the internal organs and muscles, the circulation in them is lessened, and less heat produced.

heat. In sitting upon that coach the skin not only of myself, but of my fellow-passengers, began to get pale as the cold continued. That paleness meant that the vessels of the skin were becoming contracted; there was less blood pouring over the surface, and therefore there was less exposure of blood to the chilling influences of the external air. By the contraction of the vessels of the skin the blood is retained in the inside of the body, and there it is kept warm. If a man be thin he has not much power of retaining heat, but he can do it easily if he is fat. In your dissections you have no doubt noticed what very small vessels go through the subcutaneous fat, and if you have a thick layer of subcutaneous fat the power of regulating the temperature and of withstanding external cold is very much greater than if you have only a little subcutaneous fat. For, instead of the blood being simply pressed back from the skin and from the subcutaneous cellular tissue into the muscular tissue below, as in a lean man, you have in a stout one a very thick coat of fat, which is a good non-conductor, between the blood and the external cold air or cold water, as the case may be. When Captain Webb proposed to swim across the Channel, I predicted with great confidence before he made the attempt that he must necessarily fail. The data upon which I made this prediction were that others had tried the same thing before and had failed, not because their muscular strength gave out, but because they got so chilled down in the cold water that their muscles could not act any longer. But I forgot that Captain Webb was a fat man, and that he resembled in this respect, although not to anything like the extent, the whale in the Arctic regions. Whales in the Arctic regions are able to move freely, and do not get their muscles paralysed, because they possess such a thick layer of non-conducting fat between the cold water in which they swim and the muscles below.

If, then, you dilate the vessels, you allow more blood to pass into the skin, and thus you cause the heat which is generated in the body to diffuse more freely into the external air or into the water, and you can notice in anyone exerting himself the action of the natural regulating power in this way. As the man gets warm through exercise the vessels dilate, and he becomes red in the face and red all over. He thus loses heat by radiation and conduction from his body. But loss by conduction is not enough, because if a man is standing still the loss of heat from his skin by radiation or by conduction by air, especially if dry, is very slight indeed.

We must have a more efficient way of reducing the temperature, and this is afforded by the secretion of sweat. The sweat becomes evaporated, and in the process of evaporation the heat becomes latent, or, in other words, is converted into the mechanical work by which the particles of water are driven apart and changed from the state of a liquid to that of a vapour. Thus in the evaporation of sweat a great deal of heat is lost by the skin. The power of the skin to resist cold in dry air is shown by the fact that in Canada, with the thermometer 40° below zero, very little cold is felt so long as the person remains absolutely still, and there is no wind. The moment, however, that there is any movement of the air, either from motion on the part of the person or from the least wind arising, the cold is felt intensely. It is this dryness of the air that allows you to send your phthisical patients up to Davos and St. Moritz in winter. Although the air is exceedingly cold, yet patients do not suffer from cold there, and in midwinter at St. Moritz, with snow as far as the eye could reach, I have seen a lady sitting with an umbrella over her head to protect her from the sun, watching other people play at lawn tennis. The reason that she was able to do this was that the air was exceedingly dry and exceedingly still, but at either of these places if you get into a part where there is the least wind then you feel the cold at once, and delicate patients feel it still more.

LECTURE 7.

Fever, *continued*—Reduction of temperature by applications to the skin —Alcohol—Ethyl nitrite—Acetate of ammonia—Bleeding—Muscles as temperature regulators—Action of drugs on muscle—Action of drugs on motor nerves—Curara.

GENTLEMEN,

As I mentioned to you at the end of the last lecture, the removal of heat from the skin by simple conduction through dry air is very slight indeed, so that a man may remain exposed to dry air for a length of time and with very little covering without feeling any cold, provided the air be not in motion. If the air be in motion, however, the loss of heat by conduction from the skin is very much greater. What holds good for air holds good for water also, and if a person stands quite still even in cold water, the conduction is comparatively slow, but if the water moves rapidly over the surface of the body, the loss of heat, provided the water be cold, is very rapid. We make use of conduction to a certain extent in cooling the skin in fever. Naturally if we wrap a fever patient up with numerous blankets we prevent the loss of heat through the skin, and we retain the heat, so that the temperature of the body remains high. An old-fashioned plan of treating fever was to wrap the patient up in red flannel and have a large fire in the room, so that the temperature was kept up high. In all probability this mistaken method of treatment was based on some chance observation, and probably the grain of truth in the erroneous treatment was that the high temperature in fever may occasionally be serviceable in bringing about a more rapid recovery in the patient. One notices that in certain cases, let us say of diphtheria, the low temperature which one would ordinarily look upon as a good sign is by no means always a good sign, and that in cases of septic sore throat a low temperature at the beginning makes you rather more anxious regarding the course of the disease than if you had the temperature rising high.

In cases of fever, where we wish to lower the temperature, we sometimes simply put over the patient's body a cradle to support the bedclothes and keep them from coming in contact with it. You will notice in using this method of treatment that the patient's friends are sometimes apt to say, "Oh, but, doctor, the patient will get cold." They are afraid, and apparently not always without reason, that a sudden cooling of the surface of the skin may give rise to internal congestion; they are afraid of inflammation being set up in some internal organ, more especially in the lungs, from the rapid cooling of the skin, so that in cases of this sort you very often, instead of covering the cradle only with a sheet, put a single blanket over it. As the blanket is kept away from the patient's skin by the cradle, and there is a considerable amount of air between the skin and the blanket, the temperature is lowered, and yet by using a blanket you prevent any too sudden change of temperature. If too sudden a change of temperature occurs it sometimes results in the patient getting a shivering and being the worse for it, but by the precaution I have just mentioned, using a single blanket instead of a sheet, you may avoid the risk of any such chill.

But very much less heat is removed from the skin by conduction than by evaporation. As I said before, the amount of heat that is used in converting the water from the liquid into the gaseous condition is very great, and so if we have the skin moist, so that water may evaporate from its surface, it becomes a powerful cooling agent. I remember an old student of this hospital telling me of his experiences on board one of the P. and O. steamers. In passing through the Red Sea, one of the stokers was brought up insensible, and then it turned out that this man could not sweat. The captain fell into a great rage and said, "If I had known that the man did not sweat I would not have taken him on board." The reason of the captain's anger was that if a man did not perspire freely he naturally lost a most powerful cooling agent, and in the Red Sea in hot weather he was very likely to be seized with sunstroke.

Cold and Tepid Sponging.—Now in fever we frequently find that the skin is dry, the perspiration appearing to be lessened instead of being increased. We try to increase evaporation artificially in fever in two ways: either we substitute something else for the natural perspiration, or we stimulate the secretion of the sweat glands by means of drugs. The ordinary substitute for sweating which we employ is sponging the surface of the body with cold water, and sponging along with cradling is a very efficient antipyretic measure. But what is sometimes even better is to sponge the surface of the body with *hot* water, because by using hot water you avoid all risk of causing a chill. You also frequently are able to do this without alarming the patient's friends, who might object to your sponging the patient with cold water on account of their fear of causing a chill, but if you use hot water this objection is not raised. The method of procedure is this:—Take a sponge, dip it in hot water, as hot as your hand can comfortably bear, squeeze the sponge out, and then wipe the whole surface of the patient's body with it; then do not dry it, but take a soft napkin and simply dab this napkin over the surface, so as to take up any water lying loose, so to speak, but leaving the skin covered with moisture, in much the same way as it would be by natural perspiration. If we then put the cradle over the patient, leaving the skin only protected by the blanket just put over the cradle, evaporation takes place rapidly, and the temperature goes down.

I think that sponging with hot water is perhaps a more efficient antipyretic than sponging with cold, because sponging with hot water tends to dilate the vessels of the skin, and you thus get a freer circulation of blood over the surface of the body in the very part of the body where the blood can be most readily cooled. For the skin is the refrigerating apparatus of the body, and by bringing blood to the surface and there exposing it to the cooling influence of evaporation you get the temperature quickly reduced.

Wet Sheet.—Another way of using cold is by means of cold affusion, and one sometimes may also use the wet sheet. The most striking example that I ever saw of the use of cold was in the case of a patient suffering from pneumonia, who was dying from hyperpyrexia without anyone knowing it, for it was before the days of clinical thermometers in this country. The patient was under the care of the late Professor J. Hughes Bennett, whose boast it was that he had never lost a case of uncomplicated pneumonia since the time that he discarded the old method of blood-letting and began that of simply supporting the patient's strength. One day, on going round, he was a good deal disgusted to find that one of his patients suffering from double pneumonia was apparently about to spoil his statistics by dying. The man was completely comatose and apparently moribund. It seemed as if nothing possibly could be done to help him, and Professor Bennett was passing on to the next bed, when a Swedish doctor, named Scolberg, who happened to be attending Bennett's clinic, said to the Professor, "May I treat the patient, Professor Bennett?" "You can do what you like with him," was the answer. Forthwith Scolberg ordered in a big tub of cold water. All the bedclothes were pulled off. A wet sheet was dipped in the water, and the patient was wrapped in it. In a few minutes it was taken off, and a second cold sheet applied. How long this went on I do not know, because, like all the rest who were watching the process, I thought that it was useless, and I went away to have my lunch. On going back about an hour afterwards, simply from curiosity to see whether the man were dead or not, I was greatly astonished instead of finding an empty bed, as I expected, to see the patient lying quiet and comfortable, apparently in an easy slumber; and he went on from that time forward without a bad symptom, and recovered perfectly in due course. So a wet sheet simply wrung out of cold water, put upon the patient for a short time, taken off again, dipped again, and frequently renewed, tends to bring down the patient's temperature.

Cold Affusion.—Instead of employing a wet sheet in the way just described, the cold may be applied by taking the patient out of bed, putting him in a bath, and pouring cold water upon him. This is known as cold affusion. It is perhaps a more rapid way of cooling the patient down than the other, but it has, of course, the disadvantage that it requires more movement of the patient than the other method, which may be used quite well for patients who are completely helpless and comatose.

Cold and Tepid Bath.—Another way of applying cold is to put the patient in a cold bath and leave him there for a certain length of time. The cold bath may either be quite cool to begin with, or, what is more generally employed, the bath may be at the temperature of the body or only a little lower, and then the temperature is gradually reduced by the addition of ice. You will find that in the new pharmacopœia of this hospital the cold bath is stated to be water at 65° F., or reduced by gradual addition of ice to 40° F. or below. Now the cold bath is a very efficient means of reducing temperature, and in cases of hyperpyrexia, where the temperature seems to be going up very rapidly and the patient is likely to die from its rising too high, the cold bath is frequently employed, but while doing this you should be careful to notice the temperature of the body in the bath. The cold bath as a means of cure is of great antiquity. The Emperor Augustus was saved by the application of a cold bath during fever, and consequently he had a great belief in his physician, Musa, who ordered it; but unfortunately in those days they had no thermometer, and they did not know how long to apply the bath. The Emperor's nephew became ill with fever also, and the cold bath was applied to him, but instead of recovering, as Augustus had done, he died from the effects of the bath. The bath was carried on a little too long. And you must remember that the chilling down continues for some little time after the patient has been removed from the bath, and you can readily see why. You have cooled down the external parts of the body and the limbs in the bath, and you generally take the temperature in the mouth or axilla of the patient while in the bath. If you bring the temperature in the mouth down to the normal while the patient is still in the bath, then after you take him out the blood which is circulating in the interior part of the body, and which is warming the thermometer up to the normal, will begin to circulate in the colder parts of the body outside, in the skin and subcutaneous tissue, and thus the temperature of the body will fall below the normal. It may fall so low that the patient may become collapsed and even die, so that you had far better remove the patient from the bath while the temperature in the mouth is still about $1\frac{1}{2}°$ or 2° F. above the normal.

Cold Pack.—The temperature of the body may be reduced by the so-called cold pack, by which, however, comparatively little heat is abstracted from the body, the effect of the pack being rather to equalise the circulation. The cold pack is applied by spreading a blanket upon a bed, and over this a linen sheet wrung out of cold water. The patient is laid naked upon the sheet, which is then rolled round him and tucked firmly in at the sides. The blanket is then rolled round also and tucked in, and over the whole, next the blanket, an eiderdown may be placed. The soothing effect of this is very great, and in cases of wild delirium the patient sometimes drops off quietly to sleep. The heat of the body soon communicates itself to the wet sheet, and being retained by the blanket outside, the effect upon the system is somewhat like that of a warm bath. Its soothing action is probably increased in cases of delirium by the enforced quiet which it produces, as the patient is unable to move hand or foot from the sheet being wrapped tightly round him up to his neck. On account of the powerlessness of the patient to help himself, he ought not to be left alone during the time he is in the pack; someone ought always to be with him. I remember once seeing a graphic description given by a patient of his sufferings when left alone after being packed. As he was lying helpless in his bed he saw a big spider walking over the ceiling, and, just when it got opposite to his face, it began to spin a long cord and gradually descend. It was clearly making for the patient's nose or mouth, but he was not quite sure which; and he underwent similar tortures to those described by Edgar Allan Poe in his story of "The Pit and the Pendulum," until fortunately the attendant entered just as the spider had descended within an inch or two of the patient's face.

Hot Bath.—Another curious way of reducing temperature is by a hot bath or a warm bath. One would not at first think that putting a child with a raised temperature into a warm bath was likely to relieve fever, and yet it frequently does so. The warm bath, as given in the hospital pharmacopœia, is water at 98° F. up to 106° F.; that is to say, the warm bath is water at the temperature of the body, or about 7° or 8° above it. One often judges of the temperature of the bath by simply putting the hand in, and the direction you give to the mother of the child, if a thermometer is not available, is that the bath shall be so called "milk-warm," so that the hand can be comfortably *held* in it. But be sure that the temperature is not estimated by simply *dipping* the hand in and then taking it out, as otherwise too hot a bath may be given. Now, you can see with a little consideration how a hot bath is likely to relieve fever. It causes dilatation of the vessels of the skin, and if the child be simply not dried, but dabbed with a soft napkin afterwards, the skin is left moist; the moisture evaporates, cools down the skin and the blood which is circulating through it, so that the temperature of the whole body is reduced. There seems to be in addition a certain soothing influence exerted by the hot bath upon the nerves of the skin, so that after the child is taken out of the bath, instead of being feverish and restless, it begins to get quiet, and very often goes to sleep at the same time that the temperature falls.

Training of Dermal Vessels.—While talking of baths, perhaps I had better discuss here the effect of baths in preventing cold. You know that all organs are capable of training; that when a man gets out of sorts, when he is having little exercise, not only do the muscles of his legs become much weaker, but his breath gets short. He cannot run in the way he could before without getting oppression at his chest, but with a little training he not only regains power in the muscles of his legs, but no longer gets so soon out of breath. In other words, his heart regains to a great extent its power of driving the blood rapidly through the lungs, and getting it there well aërated. But what holds good for the heart and pulmonary vessels in training also holds good for the vessels of the skin. If an animal be kept at a high temperature for several days, the vessels of the skin appear to lose their power of contraction; so that if it be then taken out and exposed to cold it will become chilled much more quickly than another animal of the same species and size which has not been kept in a warm chamber. We thus see that people who are accustomed to live in overheated rooms are more likely to suffer from chills than those who live in a temperature which is not much above the proper one for the body. We can to a certain extent restore the power of contraction to the vessels of the skin by training them. If you give a man a cold bath, or, perhaps, what is still better, a simple wash-down every morning, with a brisk rub afterwards, the quick contraction which follows the application of cold is succeeded by rapid dilatation which occurs after the cold has passed off, and is increased when the skin has been stimulated by rubbing with a rough towel. This seems to cause a training of the vessels, so that they are able to react readily to any stimulus that may be applied to them. If a man whose skin is in training in this way goes out and is exposed to a cold wind, his vessels at once contract and keep the blood warm in the centre of the body, so that he is not chilled, like one whose skin is not in training.

Alcohol increases Heat Loss.—Now, amongst the drugs that are used as antipyretics, I may mention one that you might at first hardly think of—viz., alcohol. Alcohol has a double action in lowering temperature: it seems to lessen oxidation, and it dilates the vessels of the skin; and yet this idea of alcohol being an antipyretic seems entirely contrary to the popular notion that alcohol warms you. The popular notion is based upon the feeling of warmth produced by alcohol, and the alcohol does warm a man in one way: it warms his skin, and warms the ends of the nerves in his skin, and thus conveys to his sensorium the feeling of warmth. It is through the condition of the nerves of the skin that we judge of temperature. A man during the cold stage of an ague fit is shivering with cold; he turns himself round and round before the fire and tries in vain to get warm. Yet if you take the temperature in that man's mouth or in his rectum, you will find it is very considerably above the normal. He is in a state of pretty high fever, and is far too warm already inside, and yet he is trying to get warm because he feels so cold. But the cold he feels is in the outside of him, his skin is cold, its vessels are spasmodically contracted, they will not allow the warm blood from the interior of the body to reach the skin, and consequently the cutaneous nerves are not warm, and the patient feels cold. At the end of the cold stage the vessels of the skin dilate, then the warm blood from the interior of the body pours over the surface, and the man feels red-hot. Although he feels so much hotter than in the cold stage, he is not really so. On the contrary, he is probably cooler than he was in the cold stage; but he is now conscious of the heat of which he was before unconscious. Now the effect of alcohol is like that of the change which occurs in the ague patient when the cold passes into the hot stage. Alcohol warms the skin at the expense of the internal organs by dilating the cutaneous vessels.

In the ordinary healthy condition of a man, when he is exposed to cold, the vessels of the skin contract, and the skin is chilly; but the blood, not being allowed to circulate through the skin, is kept warm, and so the heart, the lungs, and the vital organs generally are prevented from being chilled down. You will find on looking at the records of Arctic observers that they did not like men to drink alcohol, and that, as a rule, alcohol is prohibited amongst men who are employed upon Arctic expeditions. But it is not only doctors or officers who prohibit alcohol under such circumstances. The men themselves have become conscious that alcohol is dangerous when there is great external cold, and one of the most striking examples of this that I ever heard of was told me by a friend who had been out in Canada. In some of the woods the lumber trade is carried on. The men who are called "lumberers" live in camps far away from civilisation. During the whole winter they fell the trees, and these are simply dragged along the snow to the nearest river, where they are made up into rafts. In the early spring, when the snow melts, they are allowed to float down, and the men float down upon them. When they get to a large town they in a very short time expend the whole of their winter's earnings in getting drunk. The moment they get into the town they set to work to get drunk, and they remain drunk till they have spent all their money. But those very men will not have any alcohol near them in the winter. On one occasion a man conveyed a cask of whisky into one of their camps, and the first thing they did was to take an axe and knock a hole in the cask, so that the whole of the whisky ran out. The reason of this was, they did not dare to have the whisky there, for if it was there they felt quite sure they would drink it, and if they drank it they were likely to die. A story of the same sort was told me by the late Dr. Milner Fothergill. A party of engineers were surveying in the Sierra Nevada. They camped at a great height above the sea level, where the air was very cold, and they were miserable. Some of them drank a little whisky, and felt less uncomfortable; some of them drank a lot of whisky, and went to bed feeling very jolly and comfortable indeed. But in the morning the men who had not taken any whisky got up all right; those who had taken a little whisky got up feeling very unhappy; the men who had taken a lot of whisky did not get up at all: they were simply frozen to death. They had warmed the surface of their bodies at the expense of their internal organs. Some time ago Sir Joseph Fayrer was out deer-stalking in the north of Scotland. He offered his flask to the keeper. The keeper said, "No, Sir Joseph, I will not take any to-day; it is too cold." And yet if he had drunk the whisky he would have felt for the time being very much warmer than before. So that alcohol tends to act as an antipyretic by dilating the vessels of the skin, and so allowing a loss of heat.

Alcohol lessens Oxidation.—It seems, however, to have a second action, viz., that of lessening oxidation in the body, and so it acts as an antipyretic in a double way; and, as I mentioned before, alcohol, which is sometimes so very injurious in health, is frequently very useful in fever, acting in fever not as a narcotic, but as a stimulant and as a food as well as an antipyretic.

Ethyl Nitrite.—There is another substance, allied to alcohol, which dilates the vessels of the skin still more. This is nitrous ether, which is really a nitrite of ethyl mixed with a certain amount of alcohol, and containing also paraldehyde. The most important constituent of nitrous ether is the nitrite of ethyl. The nitrites all dilate the vessels of the body generally, and the nitrite of ethyl is no exception to the rule. As I have said, it dilates all the vessels. Nor is this all. It tends to dilate the vessels of the body generally, but it dilates those specially to which its action is, as one might say, directed. The result of this is that we can to a certain extent alter the vascular area affected by this drug by altering the conditions under which we administer it. If, for instance, you give a man a dose of nitrite of ethyl in the shape of spirits of nitrous ether, and expose him to cold, you produce diuresis. The reason of this is that, although the nitrite of ethyl tends to dilate all the vessels, it is prevented from exerting its action upon the vessels of the skin, as these are kept in a condition of contraction by the cold to which the surface of the body is exposed. The drug, therefore, dilates those that are not exposed to this stimulation, viz., the vessels of the internal organs, especially of the kidney, and so diuresis is produced. But if you keep the skin warm and give nitrite of ethyl, you then get diaphoresis, increased dilatation of the vessels of the skin, and increased secretion of sweat.

Acetate of Ammonia.—Another substance which tends to act as an antipyretic is acetate of ammonia. The citrate of ammonia has a similar action, but is not so frequently employed as the acetate. The acetate of ammonia, unlike the nitrite of ethyl, seems to have comparatively little action upon the vessels of the skin, but it increases the secretion from the glands and thus supplies moisture for evaporation. This tends to cool the body, and a mixture of these two drugs, acetate of ammonia and spirit of nitrous ether, is one of the oldest remedies for fever, and is even now one of the safest.

One great advantage of this combination is that by using it you get the vessels dilated, and the skin becomes moist, while at the same time you do not run any risk of producing a condition of collapse by the administration of this drug.

Antipyrin.—Other antipyretics having a more powerful action are antipyrin, phenacetin, antifebrin, and a number of other substances nearly allied to these in their chemical constitution.* These frequently tend to produce very profuse diaphoresis and to lower the temperature very rapidly. These substances are more liable to cause collapse than the old-fashioned febrifuge mixture made up of acetate of ammonia and spirit of nitrous ether.

Quinine.—Quinine is allied, to some extent, chemically to these substances. It has much more power than they to lessen the production of heat, but it does not seem to have the power of increasing the secretion of sweat to anything like the same extent as antipyrin and phenacetin. There are other drugs which have also an antipyretic power, and are sometimes used for this purpose, their action being to slow the pulse, and thus depress the circulation. The chief examples of this class are aconite and digitalis, and a drug much used for this purpose in America is hellebore. They all tend to slow the pulse and to lessen the circulation, and, I suppose, in this way to reduce the temperature. The action of these drugs as antipyretics is evidently a very complex thing indeed, and I do not know that I can give you any very exact explanation of how they lower temperature.

Bleeding.—Another way of lowering temperature is by bleeding. Bleeding may be either local or general. Local bleeding is sometimes very useful in lessening inflammation. In inflammatory conditions of the eye, for example, local bleeding by leeches, applied to the temples, is frequently very serviceable. Local bleeding is one of the best means of relieving the pain which accompanies pleurisy. When you get a patient complaining of severe pain due to pleurisy, the ap-

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* For a detailed consideration of these, see the author's "Introduction to Modern Medicine" (London : Macmillan & Co.).

plication of a few leeches will very often relieve the pain much more quickly than anything else. In cases of inflammation in the throat leeches have also been used; in inflammation of the liver they may be applied over it or to the anus, and in meningitis behind the ear. The method of applying them I will show you in next lecture, and I will then give you also some rules about using them, how to make them fasten, and so on, and how to take them off, as well as how to avoid danger from their application. Another way of bleeding is by cupping, and this also I shall show you in the next lecture.

General Bleeding.—To pass on to general bleeding. Bleeding from the arm is a mode of treatment that has now gone rather too much into disuse. The reason why it fell into disfavour, after being universally employed, was simply that, like other powerful methods of treatment, instead of only being used it was very much abused. As an illustration of this I may mention a case recorded by the late Marshall Hall. A country squire, a strong, healthy man, went out hunting one day. He was thrown from his horse, and broke a couple of ribs; he was taken home, put to bed, and the doctor was called in. The doctor felt the pulse; the pulse was full and bounding; he took out his lancet and abstracted 30 ounces of blood from the squire's arm. Next day he came back again; the pulse was still full and bounding; he abstracted 30 more. The third day the pulse was still full and bounding; he extracted 30 more. On the fourth day the pulse was still bounding, but not full, as before, so he extracted 20 ounces. On the fifth day he thought 10 would be sufficient. He abstracted altogether 120 ounces of blood in five days. On the sixth day he was holding a consultation with some other doctors over the patient in which the advisability of applying leeches was discussed, but before they finished their consultation the patient died. Well, you can see that cases of this sort naturally led to the disuse of bleeding. But bleeding as a means of relief is sometimes a very good thing indeed. When the right side of the heart is very congested and labouring, so that the veins of the neck are turgid, the face blue, and the arterial pulse very small, bleeding from the arm is, I think, of the greatest service, and you may sometimes by this means, I believe, get your patient round. The tension in the right side of the heart is relieved very markedly by the bleeding, and after the start thus given to the circulation it often becomes sufficiently restored to maintain the life of the patient. The cases in which I have used bleeding myself in practice have been cases of cardiac disease, and pneumonia, and certainly in these conditions I have seen very great relief follow it. Others might have said this relief was not due to the bleeding, but anyhow it came so soon after it that it seemed to me that they might well be regarded as cause and effect. Further, you will find, if you consult the most recent researches on bacteria and their products, that bleeding is coming into fashion again as a way of removing poisons from the body. There is certainly one condition in which it is very useful, whether it act by removing poison or not, and that is in cases of coma due to kidney disease. In cases of uræmic poisoning, where the patient is comatose, you cannot do any harm by bleeding, and you will very likely do him a great deal of good. The amount of bleeding that is justifiable will vary with the patient. As a rule, I do not think you want to take very much more than somewhere between 10 and 20 ounces of blood. You cannot do him any harm, and probably, as in the cases where I have tried it, one gets all the good one wants from the removal of 10 to 20 ounces. Now, in some cases of local bleeding by means of cupping or leeches, and also in some cases of general bleeding, the relief sometimes follows so soon that it is hard to believe that the whole of the relief is due simply to lessening the amount of blood or lessening the tension in the blood-vessels.

Bleeding a Form of Serum Therapeutics.—For my own part, I am inclined to believe that leeching, cupping, and bleeding are all, to a certain extent, forms of serum therapeutics; that, as a consequence of bleeding, we get a greatly increased transudation of juice from the tissues into the blood-vessels. We thus alter the constitution of the circulating fluid, and thus are practically using serum therapeutics. We have not actually taken a bit of an organ or tissue, as we do when we heal myxœdema by introducing into the system the thyroid gland or its juice, but we have taken their juices from the various glands and tissues of the patient's body by drawing them into the partially emptied blood-vessels. By getting these juices from the patient's organs into his blood, we have altered the composition of the circulating fluid, and we are really trying a plan of serum therapeutics. This is a subject that I think would well repay a great deal of research, for the uses of tissues, tissue juices, and serum therapeutics are just the beginning of a new era in the treatment of disease, and when we understand the action and interaction of the various organs of the body upon one another, and how the removal of its juice from the one and its introduction into another will alter the physiology of the different organs, then we shall be able to use bleeding, not haphazard, as they did in the case described by Marshall Hall, but with our eyes open and knowing all about it, so that we shall avoid all its dangers and gain all its benefits.

Now, curiously enough, bleeding in a healthy man or a healthy woman tends to raise the temperature. The tissue juices of which I spoke, when introduced into the blood, seem to tend to increase tissue change in the body, and so you get a rise of temperature, and yet somehow or other bleeding is occasionally a useful antipyretic in disease.

Purging.—There is another agent that is sometimes useful as an antipyretic, and here the *modus operandi* is more easily understood, and that is purging. Now purging also tends to act as a process of serum therapeutics.

You have, on the passage of a purgative through the intestine, a quantity of fluid poured into the gut from its glands, but there is also a quantity of a different fluid going from these glands into the body generally (*cf.* pp. 49 and 50). At the same time, the purgative clears out of the intestine a lot of substances that were there, and amongst other things which are cleared out are probably the products formed by the innumerable bacilli that are present in the intestine. Some of those products, no doubt, give rise to an increase of temperature; and especially in children, in whom the power of maintaining a steady temperature is less than in adults, you find that constipation is frequently followed by a rise of temperature, and that the process of clearing out the intestinal tube by a purgative lowers the temperature and restores the child to health. Not only does it restore it to health, but you will sometimes find a most marked change in the temper after the administration of a purgative. I have one day seen a little child just as naughty as it could possibly be, and next day, after a small dose of grey powder and some rhubarb, the child had become a little angel without wings. You had simply completely altered its temper and disposition by clearing away a quantity of some substance or other from its intestine and preventing its absorption from the intestine into the circulation.

Muscles as Temperature Regulators.—In speaking of the regulation of temperature, I have mentioned the muscles as being one of the chief factors in keeping the temperature constant, because during muscular contraction there is increased production of heat, and during muscular action the vessels of the muscles become dilated, so that more oxygen is brought, whereby the oxidation is increased in the muscle, and at the same time the increased heat is transferred by the blood passing from the muscle to the rest of the body. Not only is it important, then, to know something about muscular contraction in regard to the production of heat, but we must know something about muscular contraction also in regard to the regulation of heat, because it is by the contraction of the involuntary muscles in the walls of the blood-vessels that the temperature of the skin is regulated.

ACTION OF DRUGS ON MUSCLE.—The most important drugs which act upon muscle are probably the salts of potash, salts of barium, and veratrine. You will find in my book on materia medica and therapeutics a number of drugs mentioned as having a powerful action upon the muscles. I am only going to refer now to those that are likely to be interesting to you in practice. I mentioned first of all salts of potash, because you will find that potash is looked upon as a very depressing agent. There is a certain amount of truth in this, for potash does tend to weaken the muscles, but only when in great excess, and it is very doubtful whether you can give enough potash to any patient to have any very marked influence upon the muscles.

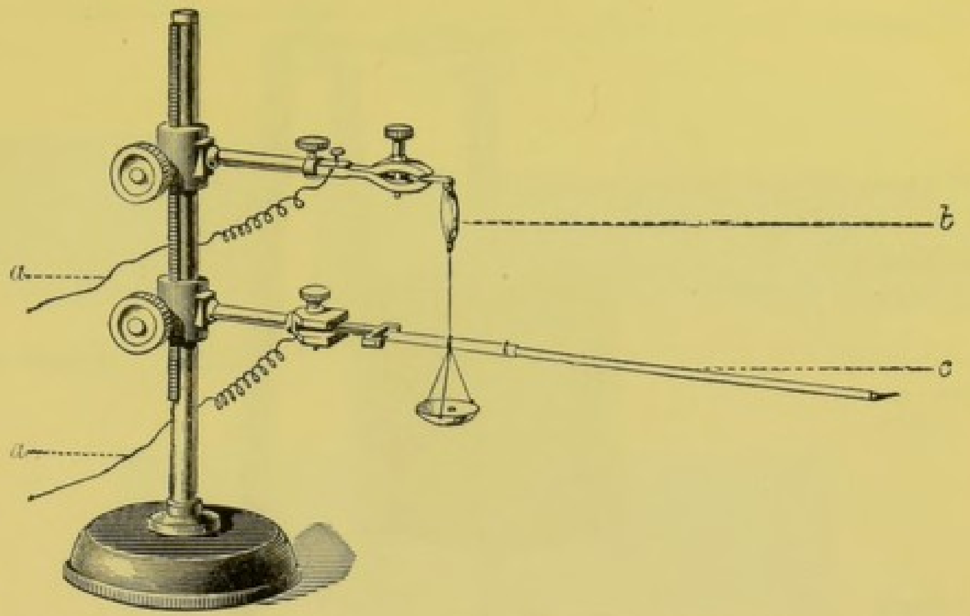


FIG. 41.—Apparatus for registering muscular contraction. It consists of an upright stand on which two horizontal bars may be moved by a rack and pinion. The upper bar ends in a clamp; the lower carries a delicate lever, the part near the hinge being of metal, and the part beyond of light wood tipped with quill or tinfoil. *a*, *a*, wires for exciting muscle; *b*, muscle; *c*, writing lever. In the figure no arrangement is shown for exciting the nerve, and for the sake of simplicity the weight is shown directly under the muscle. In actual experiment, however, the weight should be applied close to the axle, or on it, so as to lessen oscillation due to the inertia of the lever.

Yet, for all that, potash has a certain weakening effect upon muscular tissue, both voluntary and involuntary. Lime, on the other hand, has a different action. It tends to make the muscle contract more powerfully, and tends also to make the contraction more slow and more prolonged. Barium has this effect to a still greater extent. You know from your physiology lectures that when you observe the muscular contraction in a frog you generally cause the muscle to register its contraction by means of a lever which writes on paper fixed on a revolving cylinder, and which is usually smoked, so that the slightest touch on the blackened surface leaves a white mark. Suppose we had here a clamp holding the gastrocnemius of a frog attached to a wooden lever; if you irritate the muscle and make it contract, and let the lever mark upon a cylinder which is standing still (Fig. 43*a*), you get simply a straight stroke, but if the cylinder is moving slowly, you get a short curve. If the cylinder is moving quickly, you get a curve (Fig. 43*d*) which is longer.

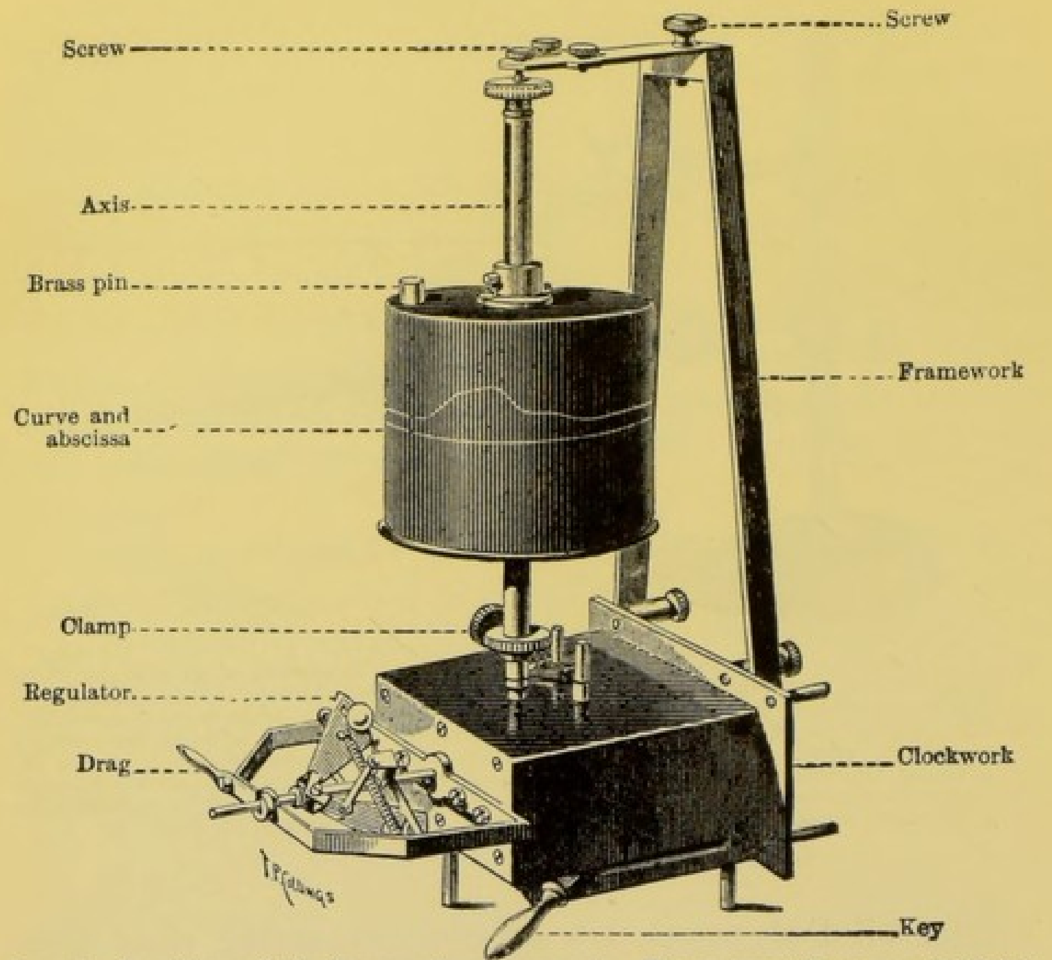


FIG. 42.—Revolving cylinder for recording movements. The screws at the top are for fixing the cylinder in position. The brass pin is for making or breaking a current at a given time in the revolution. It does this by striking against a small key. The curve is described by the lever, Fig. 41. The abscissa, or zero line, is drawn by a fixed point, and serves to show the height of the contraction.

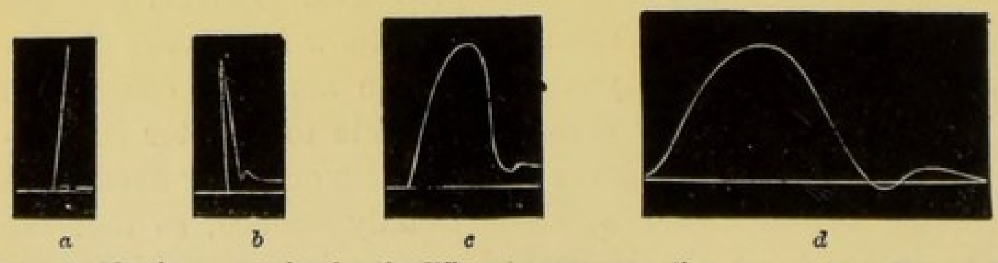


FIG. 43.—Muscle curves, showing the different appearances they present according to the rate at which the recording cylinder revolves. *a* is a curve with a very slowly revolving cylinder; *b*, *c*, and *d* are curves with increasing speed of rotation. *c* is written with a lever pointing in the opposite direction to that with which *a* and *b* are recorded and the curve therefore inclines to the other side.

Action of Heat, Cold, and Fatigue.—Heat renders muscular contraction greater, quicker, and of shorter duration. Cold has an opposite effect (Fig. 44*b*). Fatigue has an action similar to cold, and so have dilute acids. so that it is probable the alteration due to fatigue is produced by the acid products of muscular waste.

FIG. 44.—Effect of heat and cold. In *a* the muscle has been artificially warmed, and in *b* it has been cooled.

FIG. 45.—Effect of fatigue.

Action of Barium and Veratrine.—If you give the frog barium or veratrine, the effect of either is almost exactly the same. Instead of getting the curve like the normal, you get a much longer one. The poisoned muscle contracts just as rapidly as the normal, and the contraction is generally greater; the curve rises rather higher, but it does not relax like the normal muscle (Fig. 46). The consequence of this is, that a frog poisoned

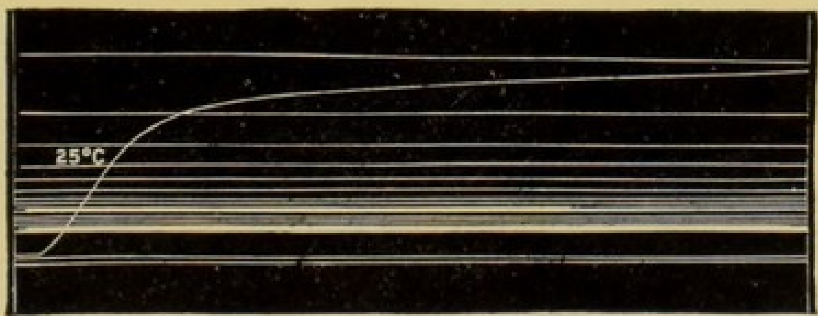


FIG. 46.—Tracing of the contraction curve of a muscle poisoned by veratrine, showing enormous prolongation of the contraction, the recording cylinder making many complete revolutions before the muscle is completely relaxed.

by veratrine or by barium and placed upon a table, will jump just like a normal frog when touched; but whereas the normal frog, when it has finished its jump, will draw its legs up preparatory to jumping again, the frog poisoned with barium or veratrine will lie with its legs extended and will only gradually draw them up again. If you touch it now you will still find the legs remain drawn up; it cannot jump, but if you wait awhile it will again jump just like a normal frog. The reason is that when you first touched the frog it contracted the extensor muscles of its legs, and gave a powerful jump, but then the extensor muscles remained contracted, and it was unable to bring its legs up again. After awhile it brought them up by using its flexor muscles, but then the flexor muscles remained contracted, so that it could not jump for a time until the contraction of the flexors had passed off. Veratrine has the power of increasing the amount of heat generated in the body, apparently by increasing the oxidation processes that go on in the muscle. A very curious point about this prolonged contraction, or "contracture" as it is termed, is that it passes off if you make the muscle contract several times in succession. Although the frog will remain in this curious extended position, if you can stimulate it so as to make it go on several times running, or if you stimulate the muscle which has been poisoned by veratrine, this peculiar contracture passes off. The muscle again becomes normal. Leave it for awhile, and it will again get stiff, but the stiffness will again pass away after stimulating it repeatedly. You can relieve this contracture in various ways. If you cool the muscle down very much you do not notice the contracture at all; if you warm the muscle up again you do not notice it. This contracture is the result of the action of veratrine upon the muscle of the frog *at a certain temperature,* and if you cool the muscle very much down or raise it above the normal, this reaction disappears. You can also remove this condition by the use of potash. If you soak a muscle that has been exposed to the action of veratrine in a weak solution of potash, or if you inject potash into the lymph-sac of a frog, so that it is absorbed, the potash will remove or prevent the action of veratrine or barium. You can, to a certain extent, counteract the effect of barium in the body by the use of potash, and some years ago Dr. Cash, who was then my assistant, and I made some experiments with the view of ascertaining how far we could prevent the action of barium by giving potash beforehand. We did not succeed in altogether preventing the action of barium and keeping the animal alive, but we delayed its action to an enormous extent, so that when two similar animals were poisoned with barium, one of them having for some days previously received a quantity of potash mixed with its food, the one that had got no potash was lying dead while the other one was apparently alive and well. But the effect of the barium was only delayed, it was not entirely prevented, and those animals to which potash had been given died also. It is probable, however, that by getting a larger quantity of potash into the body we might have been able to prevent altogether the action of the barium. We are not able to counteract the effect of veratrine so markedly as that of barium by the administration of potash beforehand.

You know the classical story of Mithridates, king of Pontus, who was very much afraid of being poisoned, and, in order to prevent the chances of this occurring, he took antidotes to all possible poisons, and thus rendered himself, as it were, poison-proof. It was to his disadvantage that he did this, for when he was conquered and wished to kill himself the poison by which he meant to end his days had no effect upon him, and he was forced to ask one of his servants to run a sword through him. Doubtless there is a certain basis of truth in the story of Mithridates, and in the action of potash in animals that are afterwards poisoned with barium we find substantiation of this idea.

I should mention that barium and calcium have the power of slowing and increasing the contractions of involuntary, as well as of voluntary, muscular fibre. This, of course, comes to be important, as we shall find out when we consider the action of drugs upon the organs consisting of involuntary muscular fibre, such as the heart. For if you get any drug which will act upon muscular fibre generally, you may say that its field of action will be very extensive indeed, because if we get a drug which will act upon involuntary muscular fibres, it will affect the involuntary muscular fibres in the vessels, in the heart, in the stomach, in the intestines, and in the bladder, so that a very large number of symptoms will be produced by a drug having this action.

To you who are going to practise medicine, it matters very little indeed what effect a drug has upon the gastrocnemius muscle of a frog, but it matters a very great deal indeed what the effect of a drug will be upon the cardiac muscle of your patients. If you know that a certain drug acting upon the gastrocnemius of a frog makes its contraction slower, more prolonged, and more powerful, and that the same drug exerts a similar action upon the muscle of the heart, then you know that in your hands has been placed a drug which may be of the utmost possible service in cases of cardiac failure, and one which may enable you to bring your patient round when the case would otherwise be hopeless. Barium is a drug which has not generally been used, but one has lately read in the papers an advertisement of the waters of Llangammarch, in Wales, as being specially efficacious in cardiac disease, and the reason why they are supposed to be so exceedingly useful is that barium exerts upon the cardiac muscle a somewhat similar action to that which it has upon the gastrocnemius of a frog. Caffeine is another drug which causes powerful contraction both of the gastrocnemius and of the cardiac muscle. It has this peculiarity, however, that sometimes, instead of causing contraction, it may cause relaxation (Fig. 48). I shall have occasion to recur to the action of drugs upon involuntary muscular fibres when we come to deal more particularly with their action upon the circulation, and also upon the digestive and urinary systems.

As I mentioned to you in the last lecture, the muscles are generally set in action by the stimulation of the nerves, and if we cut the nerves or destroy their functional power, we render the muscles inactive. By rendering the muscles inactive, we lessen the supply of heat, and so it is found that if an animal be poisoned by a drug which will arrest the muscular movements, the temperature falls very considerably.

The apparatus we have before us is to show the effect of veratrine upon the muscle. We have simply here a lever, and to this lever is attached the gastrocnemius muscle of a frog. You will see that when the muscle is irritated the lever rises quickly and falls quickly. We have no drum, so that you will

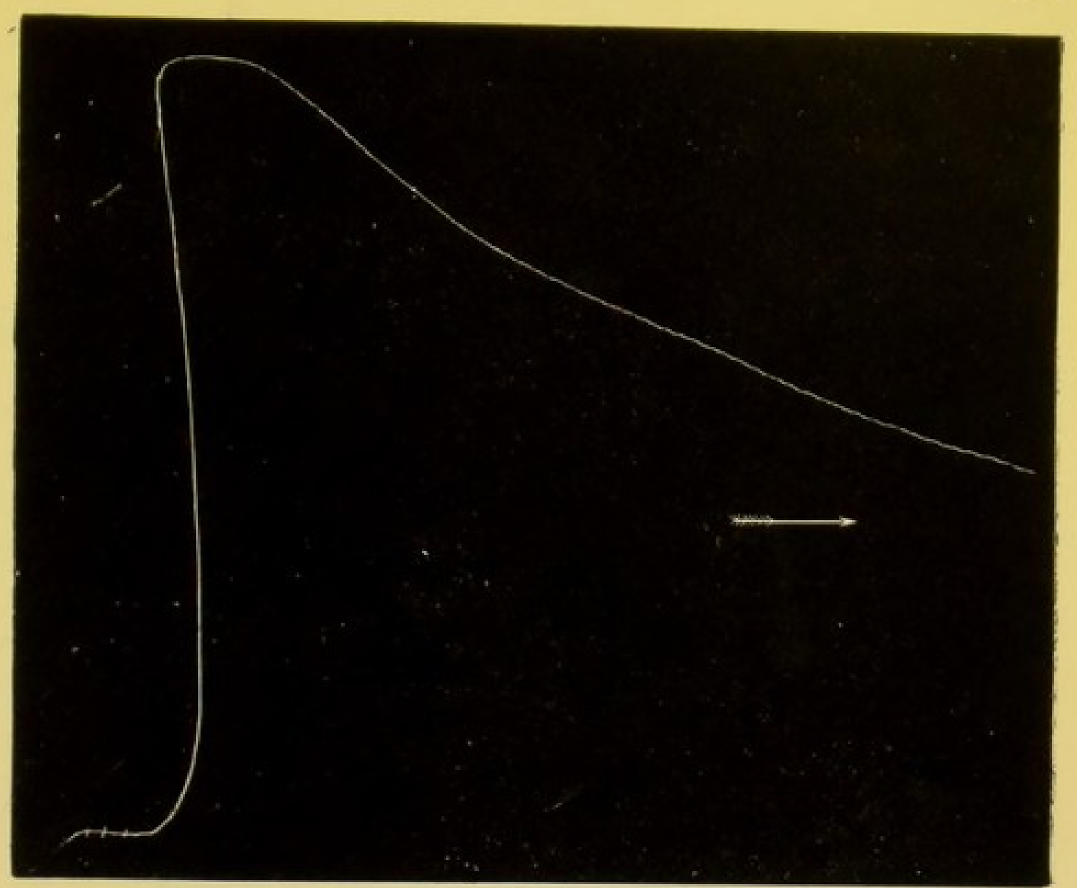


FIG. 47.—Action of caffeine on the gastrocnemius of the frog. Weight suspended, 10 grams in all. Lever multiplies 10 times.

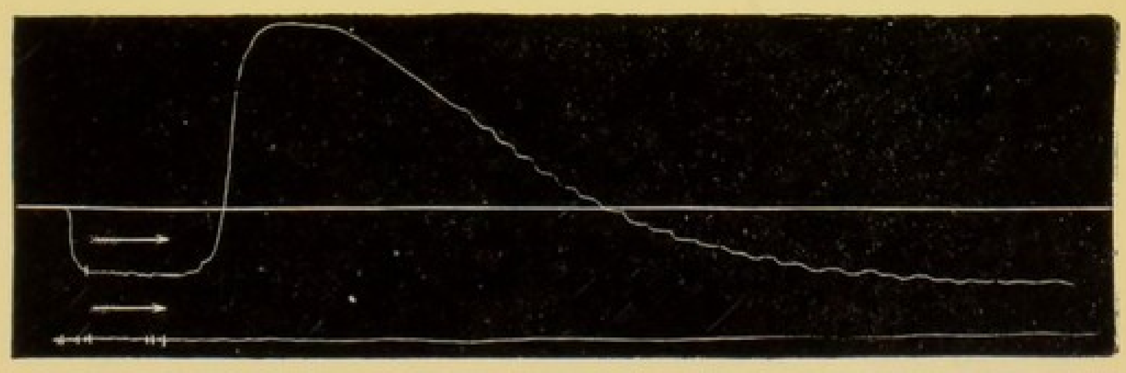


FIG. 48.—Showing elongation of muscle with rhythmic contraction produced by theine. The straight line in the middle of the curve indicates the position of the lever with the muscle at its normal length.

not see any curve. If we add more veratrine, we shall get the rise just as quick, but the fall will be slower. There is one other point, however, that I must also mention, viz., that not only is the effect of veratrine lessened by potash, by heat, by cold (Fig. 49), by repeated stimulation, but by veratrine itself. It is rather difficult to show the effect of heat and cold, so we

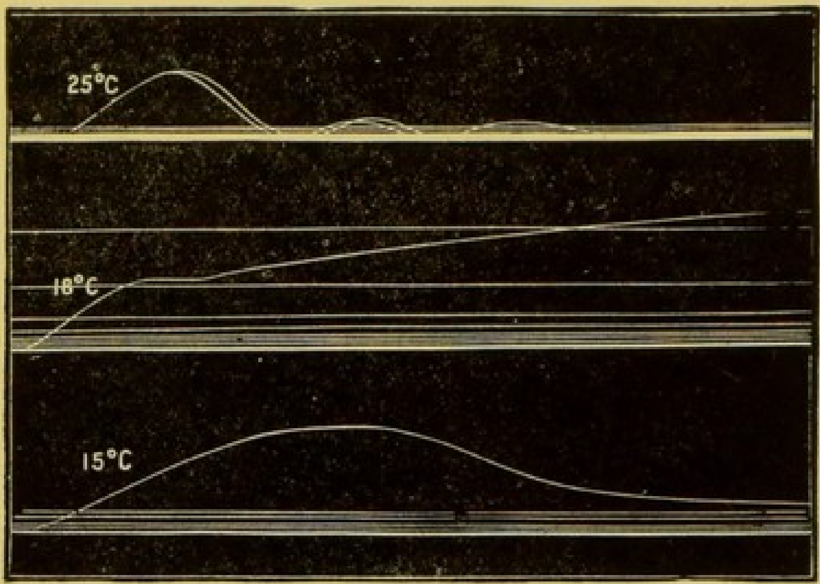


FIG. 49.—Tracing of the contraction curves of a muscle poisoned by veratrine, showing the peculiarly elongated curve at a moderate temperature, and its restoration nearly to the normal by cooling and heating.

must content ourselves by seeing the effect of repeated stimulation. You see that on the first stimulation we get a quick rise, succeeded by a very slow fall, and after several stimulations we find the fall will become almost as quick as normal. Naturally when one wishes to show an experiment to a class one tries to do it under the most favourable conditions, and one thinks that by using a pretty strong solution of veratrine the effect will be much more marked. One day I was trying to show this experiment, but I failed, and could not understand why I did so. I found that one muscle contracted readily and fell readily. This muscle was the one to which veratrine had been applied, and it seemed to me to fall more quickly than the normal one. I thought that some mistake had been made, and the muscles had got transposed somehow. It turned out, however, that the muscle which fell more quickly than the other was really the muscle that had been soaked in a solution of veratrine, but a large quantity of the poison had been used, and this appeared, as we may say, to counteract the effect of a small dose. This is a very important point, because there is one drug, aconite, which has an action very like veratrine, and aconite in largeish doses, to a certain extent, appears to counteract the effect of the small dose.

Action on Motor Nerves.—As a rule, muscles are put into action by the nerves with which they are supplied, and we have drugs which will act upon the motor nerves, and thus set the muscles in action, or which will paralyse the motor nerves and prevent the muscles from acting.

Curara.—The most marked example of a drug which paralyses the ends of the motor nerves is curara. A day or two ago, I was taking a journey into the country, and feeling very lazy and disinclined either to read Materia Medica or any other medical subject, I bought a book of detective stories at the railway station. One of these stories had a special interest for me. A detective was asked to investigate the case of two men who had been found dead. One of them had been at dinner one day with some friends; he went out, as they supposed, to smoke a cigarette, but as he was very long in returning, they went out to look for him, and discovered him lying dead. His body was swollen, his face discoloured, his blood would not coagulate, and the doctor was called in to discover the cause of death. He could find no trace of violence upon the body, and was of opinion that the patient had died of some unknown disease. Curiously enough, about a year afterwards another man died in the same way, with precisely the same symptoms, and the only thing that could be found upon him was a little scratch behind the ear. The detective was sent for, and he could not make out at all what either the scratch or the death was due to. But I see the hour is up, so we must continue this subject in next lecture.

LECTURE 8.

Action of drugs on motor nerves, *continued*—Localisation of action of drugs—Action of drugs on sensory nerves, on sensorium, on motor and sensory parts of spinal cord.

GENTLEMEN,

At the end of last lecture I was telling you about two men who had died suddenly near the same place at about a year's interval. No definite cause could be assigned for their death, but it was supposed to be some unknown form of blood poisoning. A small scratch was observed behind the ear of the second, and a detective was employed to find out, if possible, why and how the two men died. For a while he was puzzled, but at last he hit upon a clue, and discovered that both these men had been flirting with a girl who had been engaged to a gamekeeper. The gamekeeper was apparently of the gipsy race. He was a moody, irritable, and sullen man, but there seemed to be no reason to believe that he had any special knowledge that would enable him to kill those men in the mysterious way it had been done. The detective ascertained that certain poisons, if inoculated into the skin, might produce death with the symptoms detailed, and, on applying to an expert, he was told that a vegetable poison from South America might cause these symptoms. Shortly afterwards he discovered that the uncle of the gamekeeper had travelled in the Amazons, and, finally, he found amongst the uncle's effects some poisoned arrows. Now, if any of you should happen to read this story, you will notice that the first man is said not to have died immediately, but to have partially recovered, and then to have had a relapse. The second man probably died without any partial recovery. I do not know whether this is a pure invention, or whether it is really a description of fact, which it perfectly well might be, but if so, the poison is not altogether a purely vegetable one. The story-teller describes the poison as having been found not merely on the points of arrows, but in an earthen pot as well, and the particulars he gives seem to show that it is woorara, or curara, that is meant. Many of you may know that the curara prepared by the inhabitants of the Amazons and Orinoco is not a pure substance, but that it consists chiefly of an extract from a particular species of strychnos, which is the active part, and that this is mixed with a mucilaginous substance to make it sufficiently sticky to adhere to the arrows. In addition to this, however, some tribes mix with it the venom of certain serpents, and the symptoms recorded in the story might very well occur if a poison thus mixed had been used.

Strychnine and Methyl Strychnine.—I wish you particularly to remember that this poison is obtained from a species of strychnos, and my reason for doing so is that curara paralyses the ends of the motor nerves, and strychnine does not. It has quite a different action. It stimulates the motor centres in the spinal cord, but if you slightly alter the chemical constitution of strychnine, you produce a poison like curara. By changing the strychnine into methyl strychnine, you change the tetanising poison into a paralysing one, and you change the position of its action from the motor centres of the spinal cord to the peripheral ends of the motor nerves. You can readily see now how curara would produce the symptoms described. The man gets a scratch behind the ear; the poison is absorbed, and is carried to all the motor nerves. These become paralysed, the man falls down powerless, and then the muscles of respiration are paralysed also, but the heart goes on beating. In this way the blood becomes venous from the stoppage of respiration, and yet the venous blood is carried by the heart over all parts of the body, so that the body at large becomes of a livid colour. The swelling and decomposition point, not to curara pure and simple, but to an admixture with serpent's venom, which has the power of decomposing the blood and of giving rise to rapid putrefaction. You will find, gentlemen, that detective stories are not only very interesting to read: they are very instructive because, although they have usually little connection with Materia Medica, they seem to me to exhibit the same faculties that one uses in solving scientific problems and in investigating the causes and treatment of disease. One of the great pleasures in all stages of civilisation, or want of it, is that of hunting. You find the original instinct of man to hunt, to follow up a track, is developed not only in the Red Indians, as depicted in Cooper's novels, but in all science, and amongst the most interesting classes of stories are those in which a detective, from a few indications, gradually works backwards until he has found the cause of the phenomena.

Localisation of Action of Curara ; Local Application.—Now the manner in which the action of curara has been localised is very instructive. When an animal is poisoned by it, it falls quite helpless. This, of course, might be due to an action of the poison upon the muscles by which motion is maintained, to an action upon the motor nerves, to an action upon the motor centres in the cord or in the brain, or to all of them together. Claude Bernard localised the action in a very ingenious way. He simply took the gastrocnemius of a frog and put it into a solution of curara in a watch-glass (Fig. 50). He then found

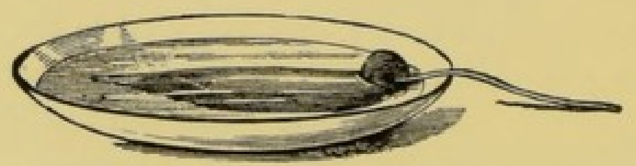


Fig. 50.—Shows the method of applying a drug in solution locally to a muscle and the ends of motor nerves within it.

that if he stimulated it directly, it contracted. From this fact it was quite clear that the poison had not destroyed the contractile power of the muscular fibres. But if he stimulated the motor nerve no contraction took place. This absence of contraction was clearly due to paralysis of the motor nerve, but as a part of the trunk of the motor nerve was in the watch-glass, it was uncertain whether the drug had acted upon the trunk of the motor nerve or upon the ends of the motor nerve within the muscle itself. By simply varying the experiment a little, he decided this question. He put the trunk of the motor nerves

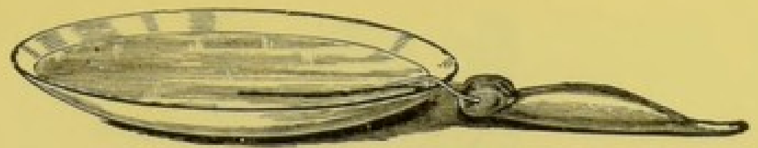


FIG. 51.—Shows the method of applying a drug in solution locally to the trunk of a nerve.

into the solution of curara and then stimulated it, but there was no change whatever in the contractility of the muscle. It contracted just as readily after the trunk of the motor nerves had been steeped in curara as before. This clearly showed that the poison had not acted upon the trunk of the motor nerve, nor upon the muscular fibres, but upon something that lay between the trunk of the nerve and the muscular fibres, and that something could be nothing else than the motor end-plates.

He therefore localised the action of curara to the end-plates of the motor nerves; but, at the same time, it was just possible that it might have acted upon some other part of the body as well. These experiments showed that it had acted upon one part, but they did not show that the poison had not acted also on other parts. We can see from them that curara poisons the ends of the motor nerves, but we cannot tell from them what action it has or has not upon the nerve centres, because, having paralysed the ends of the motor nerves, we have taken away the only index by which the nerve centres can give evidence of their functional activity.

This first mode of localising the action of drugs we may term that of "local application"; the second is that of "local exclusion."

Local Exclusion.—In order to ascertain the action of the poison upon other parts of the body, Bernard tied the artery going to the leg of a frog. He then placed a little curara in the dorsal lymph-sac of the animal, so that the poison was carried to every part of the body except the one leg the artery of which was tied. In the diagram (Fig. 52), I have represented the poisoned part of the frog's body by shading, and the part which was not poisoned I have left unshaded. In order to find out, then, whether the sensory nerves and the reflex centres were affected or not, Bernard pinched the poisoned leg of the frog, and he found that, although no reaction took place in it, the

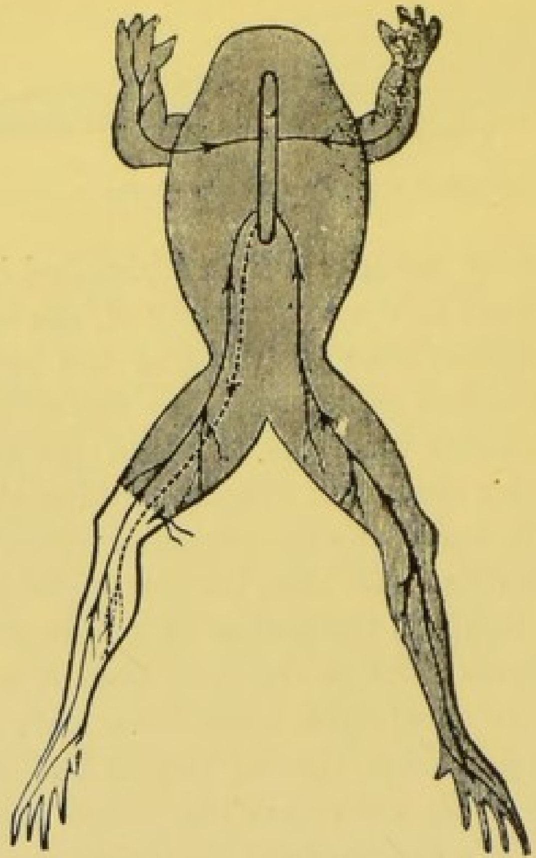


Fig. 52.—Diagram of the mode of experimenting on motor and sensory nerves in the frog. The shaded part shows where the poison has been carried by the circulation; the unshaded left leg shows where the tissues have been protected from the poison by ligature of the artery just above the knee. The unbroken lines with arrows pointing to the spinal cord indicate the sensory nerves; the broken line with arrows pointing outwards indicates the motor nerve to the unpoisoned leg.

unpoisoned leg reacted at once. It was clear, therefore, that at this stage of poisoning the poison had not paralysed (1) the ends of the sensory nerves, nor (2) the trunks of the sensory nerves, nor (3) the reflex functions of the spinal cord, nor (4) the trunks of the motor nerves, because all those parts lay within the poisoned area. The next thing was to ascertain whether they were affected later on or not. They were clearly not paralysed at first, but as the poisoning became deeper and deeper it was noticed that pinching, even of the poisoned leg, ceased to cause any reaction in the unpoisoned leg. Clearly, then, the poison paralysed some other structure than the motor nerve-endings. The next step was made by Schiff, who found that, although the action of curara is exerted chiefly upon the motor nerves, it does, to a certain extent, paralyse the sensory nerves also. He found that when the poison has acted for a considerable time, if you pinch the skin just above the ligature in the thigh of the unpoisoned leg in the part to which the poison has reached, and which is shaded in the diagram, you get no reaction in the unpoisoned leg and foot; but if you pinch the skin below the ligature at the part (not shaded in the diagram) where the poison has not reached the sensory nerves, you get a reaction in the unpoisoned foot. From this we see that the poison does paralyse the ends of the sensory nerves as well as of the motor. At a still later stage of poisoning, it is found that the reflex power of the cord also becomes paralysed, because no pinching, either in the poisoned or in the unpoisoned area, will bring about any further reaction.

There are various other poisons that act like curara and paralyse the ends of the motor nerves. I have already mentioned one of them: methyl strychnine. Now, all the tetanising compounds, when they are converted into methyl compounds, lose their power of tetanising and become changed into paralysing poisons. One of the most important of the tetanising poisons is ammonia and its salts. Many of the compound ammonias have likewise this action, but when we get an ammonium salt converted into a methyl ammonium one, then the tetanising action of the ammonium becomes a paralysing one, and a great number of the compound ammonias have got this paralysing effect. Now this is of considerable importance, because we know from accidental experiments with curara that before total paralysis sets in a condition of great weakness, languor, and depression is felt.

One of Claude Bernard's assistants one day scratched himself, and got a little curara into the wound. It did not kill him, but it produced in him the feeling of muscular weakness and languor which I have just described. Another poison that paralyses the ends of the motor nerves, amongst other things, is conine, and the symptoms it occasions have been well described in the case of Socrates, whose legs became weak while his brain was still perfectly clear, and he was obliged to lie down because his legs became unable to support him.

Curara-like Action of Ptomaines.—From the decomposition of albumin in the intestines, a great many poisons are formed, some of which belong to the series of compound ammonias. Probably it is some of them which by exercising a paralysing action on motor nerve-endings give rise to the weakness and languor so often associated with indigestion, and which one can frequently remove by simply sweeping out of the intestine the decomposing products it contains.

Action of Agents on Sensory Nerve-endings: Cold.—I mentioned just now that curara has likewise an action upon the ends of the sensory nerves. There are certain other substances that also lessen the irritability of sensory nerves, and are thus useful as local anæsthetics. Amongst the most powerful of these we may reckon cold. Cold when applied to the surface gradually lessens and finally completely abolishes the irritability of sensory nerves, so that any painful stimulus acting on the skin no longer produces any effect. Cold may be applied simply in the form of ice, and we very often use this for the purpose of local anæsthesia in the throat. By making persons suck a piece of ice, we get the irritability of the pharynx greatly diminished, and until within the last ten or twelve years this was the plan that we invariably followed in cases where the larynx was irritable, and we were unable on this account to use the laryngoscope. Now, however, we have got a very much more powerful agent than cold for this purpose, viz., cocaine, although cold is still very often used as a local anæsthetic application to the skin. It is inconvenient to use ice in most cases, and we generally employ freezing by ether spray or by some spray which evaporates very readily, such as chloride of methyl or chloride of ethyl. Both these substances produce cold very readily, and the local application of such cold is very useful in opening small abscesses or when you wish to make a puncture, *e.g.*, when you wish to run a needle into the chest in cases of pleurisy or empyema.

Carbolic Acid.—Carbolic acid and its allies are all more or less powerful local anæsthetics, and one way of producing local anæsthesia formerly was to paint some strong carbolic acid over the part where we desired to make the incision. For example, in opening a boil, strong carbolic acid was first painted over it, and the incision was then made. You thus got the antiseptic effect of the carbolic acid, as well as its local anæsthetic action.

Cocaine.—The most powerful of all local anæsthetics is cocaine, which when applied to the surface of a mucous membrane destroys its sensibility, so that it may be used to render the cornea insensitive for operations upon the eye. One is thus enabled to dispense with the use of general anæsthetics in many operations upon the eye, and one great advantage of this circumstance is that one does not run the risk of getting the vomiting and straining which might be injurious to the eye after the operation, and which we frequently meet with after the administration of either ether or chloroform. Cocaine is also used for the production of local anæsthesia in the throat. In cases where the throat is very irritable, so that you cannot well see the larynx, you just take a brush dipped in a 5 per cent. solution of cocaine, smear it well over the pharynx, and leave it for three minutes. Then you probably find when you introduce your mirror again that the throat has become insensitive, and that you are able to move the mirror about without inducing any attempts at retching. Sometimes cocaine is used also to inject under the skin in cases where you wish to make an incision, as in opening an abscess. A curious condition is, however, sometimes brought about if the cocaine is used too strong. A gentleman, a teacher of physiology, described his own experiences to me in the most striking way. He wanted to have a tooth extracted, and the dentist injected a lot of cocaine into the gum. It had the curious effect upon him of completely removing all power of movement, although it left his sensorium unaffected. He was unable to move, unable to breathe, and they had to maintain artificial respiration for many hours, after which he recovered completely.

In using a spray of anæsthetic ether, as you direct the spray upon the skin, after a short time you usually find that the surface of the skin becomes quite pale and cold and freezing; at the same time it becomes anæsthetic.

Local anæsthetics are employed not only to render examination of the larynx more easy, but also in the case of other mucous membranes. For example, where you have reason to suspect that there is some disease in the rectum or in the uterus, and where the anus and the vagina are both excessively sensitive, you may use cocaine in order to diminish sensibility.

Itching.—We also use local anæsthetics for the purpose of removing itching. Now itching is one of the most awful symptoms, I think, that can possibly afflict mankind; it is almost worse than pain, and if you read Dante's "Inferno" you will find that one of the divisions of hell was inhabited by people who were simply affected with intolerable itching all over. Now, such general itching occurs in jaundice, in Bright's disease, and in some cases of eczema. You find it also, though, perhaps, to a less extent, in urticaria, and some allied disorders. In order to relieve the itching, one uses many different drugs. One of the most common is a solution of carbonate of soda or of potash, another is diluted acetic acid, and sometimes the best results are obtained from alternating those two. Carbolic acid and its congeners, which act, as I have said, as powerful local anæsthetics when applied pure and simple, remove itching, and one of the best ways of removing itching is, I think, to use either carbolic acid or some similar drug, such as liquor carbonis detergens. When these are sponged over the surface of the body the itching is readily relieved. For small patches of eczema cocaine may be used freely, to lessen itching, but you cannot employ it over the whole surface of the body. Occasionally you find that a very hot bath tends to lessen itching considerably. Many of you may have noticed that just before you begin to perspire after exertion there is a good deal of itching to be felt in the skin, and as soon as you begin to perspire this disappears. The itching appears, therefore, to be due to some congestion of the lymphatic vessels or lymph spaces irritating the peripheral nerves, and a hot bath seems to act like perspiration in relieving this. As you might expect, jaborandi and its active principle, pilocarpine, which cause profuse sweating, are sometimes beneficial in skin diseases attended with great itching. One of the most useful remedies that we have for lessening itching locally is hydrocyanic acid, and we have in the hospital pharmacopœia a lotion containing a little hydrocyanic acid, water, and glycerine.* The disadvantage of this is that you cannot apply it over a very large surface, because hydrocyanic acid is such an exceedingly powerful poison that you can only apply it over small surfaces at a time, otherwise you run the risk of absorption and possible fatal results. Another drug that is exceedingly useful in lessening itching is alcohol. There are a lot of patients who are almost driven wild by intolerable itching of the anus, or of the scrotum. There was one patient who died in this hospital not very long ago in consequence of this affection. This poor man was suffering from intense itching of the anus, which was only relieved by firm pressure, and he found first of all that by sitting upon the corner of a table he could get relief, and then he tried various other things, and the last thing he tried was, I think, a jam-pot, or something of that sort. He pressed upon this with such force that it went into the rectum, whence it had to be removed, and he died in consequence of the operation. This itching may be very often relieved by the use of spirit, and the most convenient form of spirit is eau de cologne. If the part of the skin that is itching be sponged with eau de cologne, the itching is generally relieved very quickly, but if there be the least crack present, the eau de cologne burns almost like liquid fire. So you tell your patients to be careful, if there be any crack, to dilute the eau de cologne before applying it, and gradually to increase the strength of the mixture until they are able to use the eau de cologne quite pure. If eau de cologne is not sufficiently strong, as in cases of eczema, absolute alcohol not only relieves the itching, but hardens the skin, and tends to cure the disease. If the spirit has got into a crack, and is causing pain, this may be relieved by blowing upon the place, so that you evaporate the eau de cologne or alcohol quickly, and thus obtain its local anæsthetic action, or you may simply take a wet sponge and apply it to the part where the alcohol is, and by thus diluting the spirit its irritating tendency is lessened, and the pain relieved. Amongst the ointments that may be

* Acidi hydrocyanici dil., ♏x.
Glycerini, ʒss.
Aq. distillatæ, ad ℥i.

used for this purpose, the best are carbolic acid, cocaine, and calomel. One does not know why calomel should relieve itching at the anus, but there is no doubt that it has this effect, and a small bit of ointment of calomel or of carbolic acid, about the size of the end of your finger, rubbed round the anus, very frequently relieves the itching, and gives ease to your patient.

Pain referred to Periphery.—Now pain is usually referred to the place from which the ends of the sensory nerves start, but, as you all know, pain is not really felt in the ends of the sensory nerves. The place where pain is felt is somewhere in the cerebrum, and you may have pain which is entirely confined to the cerebrum, and has no source outside of it. Cases are recorded of hysterical pain in which the patient has complained of intense pain, say in the knee, and the pain has been so bad that the legs have been amputated, and the joint has been then found to be perfectly healthy.

Pain arising in Sensorium.—Other pains of a so-called hysterical nature are found in various parts of the body, and in them also there is no definite local cause for the pain, the source of pain being entirely in the sensorium. The sensation of pain rises into consciousness only in some part of the brain which we may designate as the sensorium; but while the sensorium may become painfully excited by some alteration confined to itself, painful sensations are most commonly originated by some stimulus which may act upon any part of the sensory nervous tract between the brain itself and the ends of the sensory nerves. Pain may have its origin in the spinal cord, or in the trunks of the sensory nerves, or in the ends of the sensory nerves. Thus we find pain occurring in disease of the spinal cord, and in locomotor ataxy the neuralgic shooting pains, so-called "lightning pains," so characteristic of the disease, have their origin in the spinal cord itself. You know that if one irritates the trunk of a nerve the irritation is not felt so much at the part where it is applied as at the end of the nerve itself. If you get a knock on the ulnar nerve—the so-called "funny-bone"—you feel a tingling, not so much at the elbow as down at the ends of the fingers, and, as you are aware, in changes of weather, men who have had a leg amputated are very apt to complain of pains in their corns. The corns, the foot, and the leg have all probably been decomposed and mixed with the ground in which they have been buried years before, and yet the patient complains of the pains in the corns. At a change in the weather the stump of the nerve in the leg becomes irritated, and the irritation which occurs in the stump of the nerve is referred to the end of the nerve, just as it would have been if the leg and foot had still been present, and the nerve had been intact.

Parts of Sensory Tract acted upon by Drugs relieving Pain.— So you see that in relieving pain we have to consider where the pain is, and how we are to attack it. We can almost always stop pain in the cerebrum by drugs that will render it functionally inactive. The most powerful of these are morphine and opium. These tend to abolish sensation, and they sometimes will remove the feeling of pain before they attack the other functions of the cerebrum. Other drugs, such as antipyrin, seem to exert their action more upon the spinal cord, and in those cases where pain depends upon irritation of the spinal cord, as in locomotor ataxy, we find that antipyrin, phenacetin, and antifebrin are more powerful in relieving the pain than even morphine or opium itself.

Drugs acting on Motor Parts of Spinal Cord.—The spinal cord may be affected not only in its sensory part by drugs, as by antipyrin, just mentioned, but in its conducting powers for ordinary sensation, as by cocaine. Cocaine, when given in large doses, does not affect merely the end of the sensory nerves, but also the conducting power of the cord itself.

The motor part of the cord may be, to a considerable extent, paralysed by such drugs as physostigmine and conine. Conine, which I mentioned before when speaking of the motor nerves, does not paralyse merely the motor nerves, but it paralyses the conducting tracts in the spinal cord as well, and you will readily remember this, because, when Socrates was poisoned by conine, his legs failed first. Conine was acting upon the ends of his motor nerves throughout the whole body, but in the case of the legs it diminished the power more than in the arms, because it was acting upon the whole length of his spinal cord,

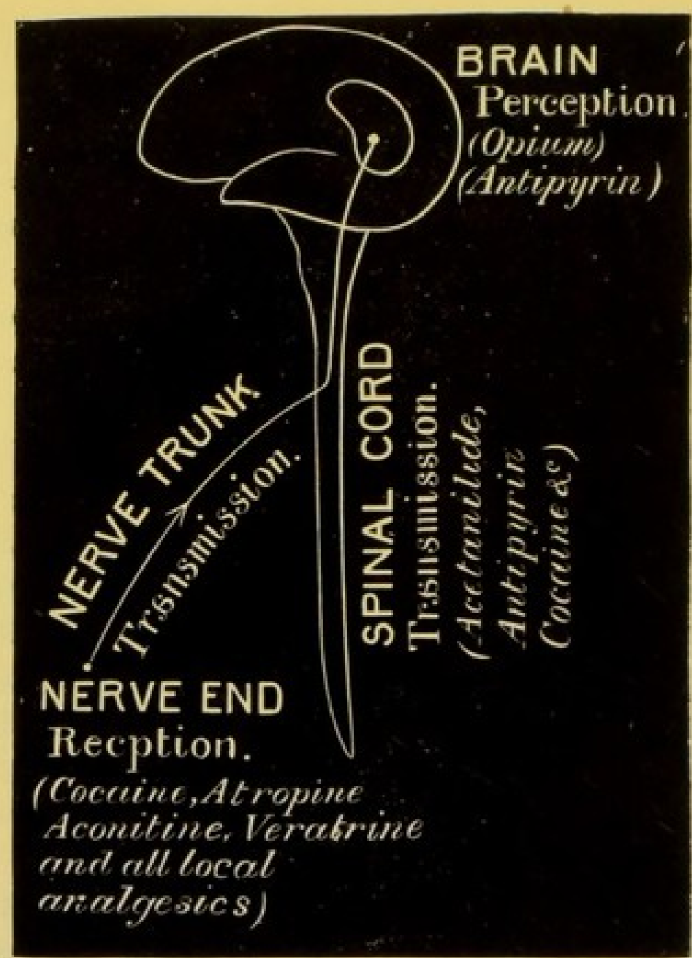


FIG. 53.—Diagram to illustrate the nervous mechanism by which painful impressions are received, conducted, and perceived, and the parts of this mechanism which are affected by particular analgesics.

lessening the conducting power in it, so that any stimulus that was passing down from the brain to the extremities would be lessened in its passage through the cord to a greater or less extent according to the length of the piece of cord it had to traverse. In the case of the arms it had to pass only through a small portion of the spinal cord before it reached the motor nerves, but in the case of the legs it had to pass through a long piece of spinal cord, and therefore the legs would fail first.

Special Stimulants: Strychnine.—Certain other drugs have the power of greatly increasing the action of the spinal cord. The most important of these is strychnine. When strychnine is given in small doses, it tends apparently to increase the motor power of the cord, so that a smaller sensory stimulus will have a greater reflex effect. When given in large doses, a very slight sensory stimulus produces an enormous reflex effect, so that when a frog has been poisoned by it a very slight touch upon the skin throws the animal into violent convulsions. The same thing occurs in mammals, so that when a man has been poisoned by strychnine the least stimulus—a cold draught of air, a jar upon the table, the violent slamming of a door, or even a loud sound—will bring on a convulsion. These convulsions are distinguished from those of tetanus, or lockjaw, by being what is termed "clonic" instead of "tonic." In lockjaw they are tonic, *i.e.*, more or less continuous; in poisoning by strychnine they are clonic: *i.e.*, each violent convulsion is succeeded by a period of rest. These convulsions appear to come on at more or less definite intervals, even when the patient is at perfect rest and protected from any irritation, but the application of any stimulus will bring on a fit at once. The patient generally dies either of suffocation during the convulsion or of exhaustion during the interval.

There is one curious point about these convulsions, and that is that they come on more quickly in paralysed limbs than in those which are under the control of the will. It is absolutely necessary that a medical man should know the action of strychnine thoroughly, and consequently a question which is often put by an examiner is, "What symptoms would lead you either to stop the administration of strychnine or to lessen the dose?" One man whom I examined said, "When the patient got convulsions I would stop." But then it is too late, gentlemen; the patient would die, and the doctor who had given the strychnine would probably be tried either for murder or manslaughter. The proper answer would be, "Whenever the patient begins to show any sign of twitching in the muscles of the fingers, then you stop or diminish the dose of strychnine." And if one arm be paralysed, it is to that arm that you look for the first indication of the action of the poison, not to the sound one.

LECTURE 9.

Action of drugs on the spinal cord—Cortical centres—Effect of position upon cerebral circulation—Effect of relative activity of cerebral circulation upon cerebral functions—Action of drugs on the brain—Stimulants—Sedatives—Hypnotics— Soporifics.

GENTLEMEN,

In my last lecture I mentioned to you that when patients have been taking strychnine or nux vomica the twitchings of the muscles, which indicate that the drug is beginning to produce its physiological effect, are more marked in the parts that are paralysed than in the normal parts.

Inhibition.—Now the explanation of this seems to be that every nerve centre appears to act upon the nerve centres below it as a coachman does upon his horses. You know that the coachman has a double action upon the horses which he drives: he is able to stimulate them to increased action, and he is able to restrain them from over-action. The higher nerve centres stimulate the lower to increased action, but at the same time they restrain them from over-action, and when you cut away the higher centres from the lower you may have one of two different effects resulting: you may have a lessened action of the lower centres, or an increased action of the lower centres. Thus we find that when the cerebral lobes have been completely removed from an animal its lower centres remain more quiescent, so that the creature, instead of moving about voluntarily, keeps perfectly still unless it is excited to movement. But if a stimulus is applied to the skin, such as usually brings about a certain reflex action in a healthy animal, the reaction to that stimulus is ordinarily greater in the animal deprived of its brain than in one that retains it. The reason of this is that, the brain being removed, the stimuli which under ordinary circumstances pass from it to the lower ganglia are abolished, and the animal is therefore quiet. Removal of the brain has, however, at the same time also abolished the inhibitory or restraining effect which it usually exerts upon the lower centres, and sensory reflex irritation therefore produces a greater reflex effect.

It is found that occasionally the symptoms produced by strychnine poisoning may be greatly lessened by keeping up artificial respiration. This has been attributed partly to the better oxygenation of the blood, which prevents the irritation of the nerve centres by venous blood. But it has been stated that the limitation of the spasms in strychnine poisoning is also due to inhibition; that the nerves of the lung are stimulated by the process of artificial respiration, and through these nerves an inhibitory action of the higher centres upon the spinal cord is excited. Now it is possible, in fact it is very probable, that some of you may be called upon to treat a case of strychnine poisoning. Of course the first thing you would like to do is to evacuate the stomach, in order to remove any poison that may still be present; but you must remember that any stimulus, however slight, is apt to bring on a convulsion, in a patient suffering from strychnine poisoning and that if you attempt to pass the tube of the stomach-pump into the patient's throat you will probably cause a violent convulsion, which may prove fatal. So it is not much good to attempt to do this unless you have lessened the irritability of the cord for the time being. This you can do by first putting the patient under chloroform; then put in your stomach-tube, wash out the stomach, and keep him under chloroform until time has been allowed for the elimination of the poison already absorbed. In addition to chloroform, chloral has been recommended. Chloral has the power, like chloroform, of lessening the irritability of the nervous centres; and it is, to a certain extent, an antidote to strychnine. By the use of chloroform along with washing out the stomach you may possibly manage to save a patient who is suffering from strychnine poisoning.

Physostigmine, as I mentioned before, has the power of lessening the irritability of the spinal cord, and it, too, has been recommended as an antidote to strychnine poisoning to be given subcutaneously, but physostigmine is not very easy to graduate in its effects, so that practically one rarely uses it.

Spinal Convulsions.—The convulsions which one notices in strychnine poisoning are of spinal origin, and it is found that if you cut through the medulla oblongata between the cerebrum and the spinal cord the convulsions will still remain. If, however, you destroy the spinal cord by means of a piece of thick wire, running it down the spinal canal, the convulsions disappear from the parts of the body supplied by the piece of cord which you destroy. If you destroy the cord from above downwards by running the wire down the spinal canal, the convulsions disappear from the upper part of the body, while they remain in the lower; if, on the contrary, the whole of the spinal cord be exposed by removing the lamellæ of the spinal canal, and the lower part of the cord be destroyed first, then the convulsions disappear from the lower part of the body, while they remain in the upper part. Conversely it was shown by Majendie that if you exposed the whole spinal cord throughout its entire length, and applied a solution of strychnine to various parts of the cord, the convulsions appeared in the parts of the body supplied by those parts of the cord to which the strychnine had been applied.

Medullary and Pontine Convulsions.—There are certain other convulsions which are unlike those of strychnine poisoning in this respect, viz., that when the cord is divided below the medulla the convulsions at once disappear. This shows that the cause of the convulsions is somewhere above the point of section, and it has been found that the places where the convulsions are most easily excited are the pons varolii and the medulla oblongata. One of the most common causes of convulsions is irritation of those parts by venous blood. I say venous blood advisedly, because it is not necessary to enter just now into the question whether it is the want of oxygen, the presence of carbonic acid, or the poisonous products of tissue waste present in the venous blood, which irritate. We will simply say that venous blood acts as an irritant to the nerve centres, and when the venous blood begins to accumulate in the vessels of the medulla and pons convulsions are apt to come on. These convulsions, if they depend upon asphyxia, may be removed by keeping up artificial respiration. There is one exception to this rule, however, and that is when the venosity of the blood does not depend upon want of aëration in the lungs, but upon want of aëration in its passage through the vessels. When the heart is arrested the blood necessarily stagnates; it becomes venous in the parts where it is lying, and so stoppage of the heart, as well as stoppage of the respiration, may bring on asphyxial convulsions. Local stoppage of circulation will do the same thing, and if the vessels going to the brain be ligatured asphyxial convulsions come on, although the rest of the body may be supplied with perfectly aërated blood.

Cortical Convulsions.—Now, there are certain diseases in which you find convulsions occurring, and one of those is known as epilepsy. The cause of the convulsions in epilepsy is, to a great extent, irritation of the medulla and pons, but the irritation in many cases does not originate in the medulla and pons, but in the higher centres of the brain.

CORTICAL CENTRES.—The higher centres of the brain may be divided into the sensory and the motor, and it is sometimes difficult to recollect the position of these centres, so I show them in a diagram. You will remember that in the spinal cord the anterior part is the motor part, the posterior is the sensory, and the same is the case in the brain. Let A (Fig. 54) be the frontal part, and B the occipital; as in the cord, the anterior parts are motor, and the posterior parts sensory. Perhaps I may be allowed to digress a little bit in order to help you to remember these facts more completely.

You know there has been a great discussion as to "what is the difference between man and woman in their mental characteristics?" Well, no doubt there is a difference between the two; but it is sometimes rather difficult to answer the question exactly and to say wherein they differ. Phrenology, when pushed to a great extent, is an absurd thing; but I think few of us have any doubt that there is a certain relationship between the size and shape of the head and the amount and character of its contents, and we may say that just as we are able from the appearance of a watch-case to make a guess at the nature of the works, so we may make a guess at the nature of the contents of a man's head from its shape. It can only be a rough guess, of course, because in a good watch-case you may get poor works, and in a poor watch-case good works, and so in the head. There is a sort of rough likeness between the two, and if you look at the difference between a man's head and a woman's head (Fig. 54) you will find that it is precisely what you might

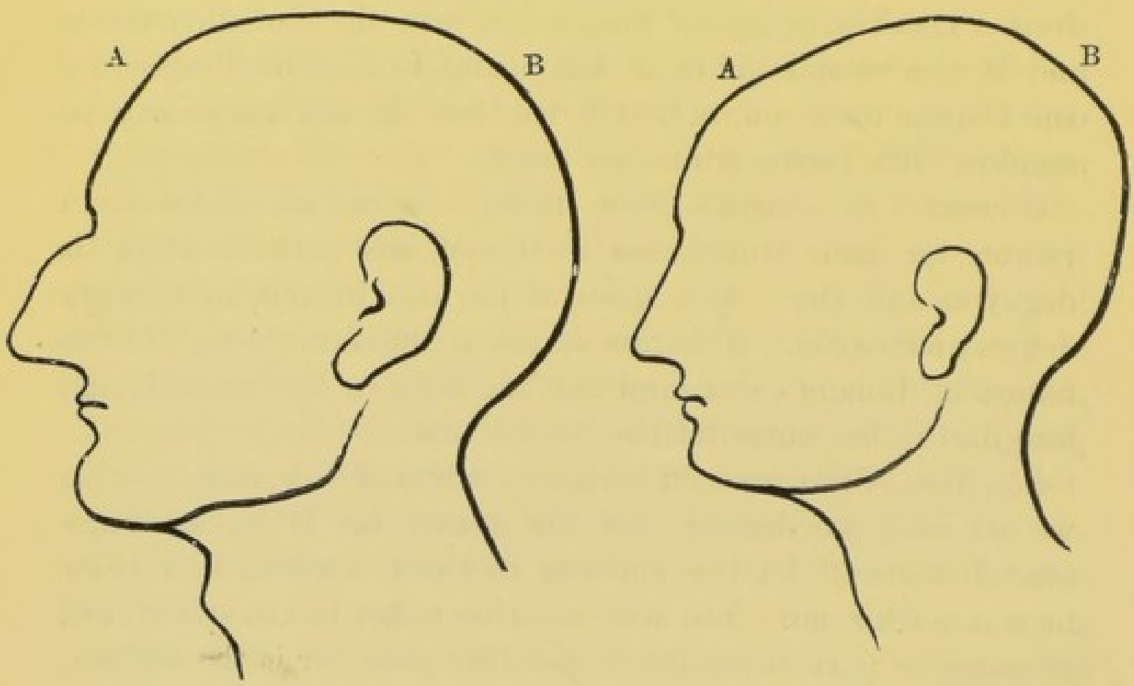


FIG. 54.—Diagram of a man's and woman's head.

expect from the different functions to be fulfilled by both in society. The man's function is to work to gain bread, and the woman's function is to attend to the children and bring them up. In order to do his work better, the man has the motor part of his brain more developed, while the woman has the sensory part developed, so that she may the better show sympathy with and take care of the helpless children. If you look at the shape of a man's head you will see that the motor part is comparatively more developed than the sensory part; in the woman you will find that the motor part is comparatively less developed, and the sensory more developed.

The experiments of Ferrier and others on animals, as well as observations upon man, in cases of trephining for local irritation in the brain from tumours, and so on, have shown that the frontal part is mainly motor, and the posterior part sensory. They have also shown that different functions are connected with certain areas of brain substance, or centres as they are termed. It is difficult to recollect the position of these centres unless you remember that the brain centres are placed in such a position as will subserve the obtaining of food by the man. It does not matter whether we look upon man as developed from a monkey, or rather from a common ancestor of man and monkey, or as starting from Adam and Eve. The Biblical and the Darwinian accounts both agree that the original ancestor of mankind lived upon fruits, and we find that the arrangement of the centres in a man's brain is such as to adapt his motor powers for using fruit as food. If you look at the brain of the dog, you find the case is quite different. In the brain of the dog you have (Fig. 55) the crucial sulcus, which corresponds to the fissure of Rolando, and around it are ranged the centre for the fore-limbs, the centre for the hind-limbs, and the centre for the tail. The tail is used in directing the animal's movement, as we see in a greyhound; but the centre for biting is several convolutions off, because the dog has to run a long time before he can get his jaws into action. This is not the case with men or monkeys. In monkeys it is "Take and eat, take and eat," and in their brains we find the whole centres of the motor arranged for taking and eating (Fig. 56). Let us take the story of Eve. She looked at the apple; she put forth her hand and took it. The centre for the forward movement of the arm is marked 2 on the diagram Fig. 56, the movement for the retraction of the arm at 3, and at the end of the fissure of Rolando (6) you get what is the end of the whole business, viz., the eating of the apple. At *a*, *b*, and *c* are the centres for the movements of the fingers in separating the seeds, and then at 7 is the movement for throwing them away, which is just the same as for bringing the apple to the mouth. In front of the fissure of Rolando, 4 (Fig. 56), this movement brings the hand to the mouth, but when the arm is already approximated,

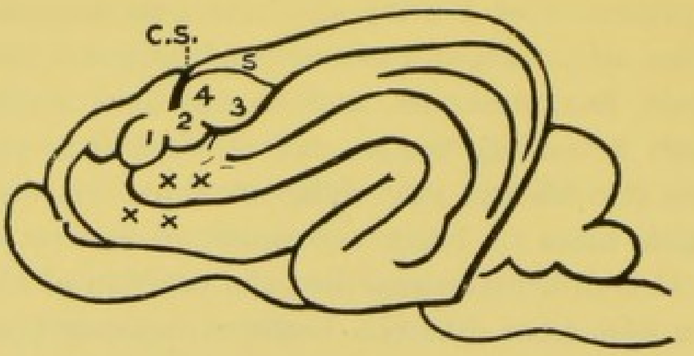


FIG. 55.—Diagram of brain of dog, modified from Ferrier. C.S., crucial sulcus: 1, movements of eyes, as if to see freely; 2 and 3, movements of fore-leg, and 4, of hind-leg, as in running; 5, movements of tail requisite in turning quickly, as when a greyhound is following a hare when it doubles; × × × movements of mouth and jaws.

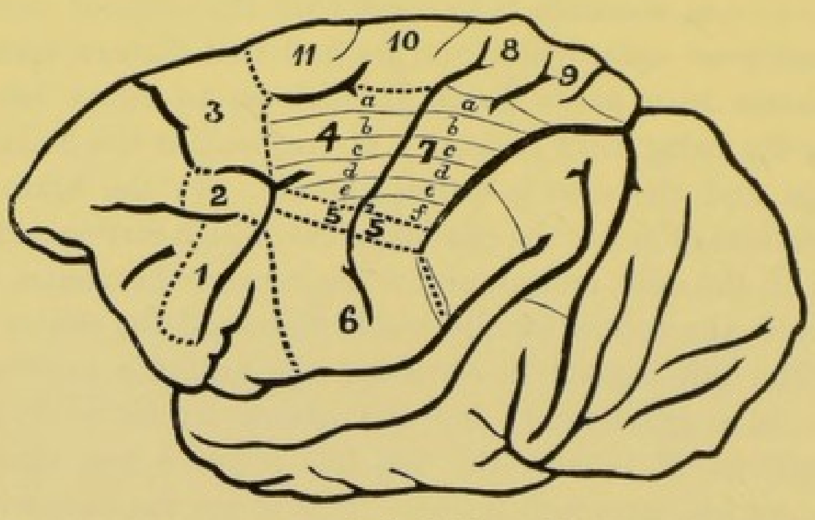


FIG. 56.—Diagram of the motor centres in the brain, modified from those of Ferrier and Horsley. The motor centres have been numbered so as to represent the successive actions in seeing, taking, and eating the apple, &c. 1, Eve sees the fruit (eyes turn to opposite side); 2, looks more eagerly at it (head and eyes turn); 3, turns towards it (head to opposite side); 4, puts forth her hand to take it (*a*, movements of shoulder; *b*, of elbow; *c*, of wrist; *d*, of fingers); 5, luxuriously shuts her eyes, so as to enjoy the sweet morsel more thoroughly; 6, eats the apple; 7, picks out and throws away the refuse (*d*, movements of fingers; *e*, of index; *f*, of thumb; *a*, *b*, *c*, as in 5); 8, 9, 10, 11, goes and gets another for Adam (8, movements of hallux; 9, of small toes; 10, of knee and ankle; 11, of hip).

irritation behind the fissure produces a continuance of the movement, with a throwing of the hand towards the other side. Next come the movements of the legs (8 to 11, Fig. 56), by which she went and got another apple for Adam. This centre is continued round in the inner side of the hemisphere (Fig. 57). So that, you see, the whole thing is comfortably arranged. In the diagram (Fig. 58) the centre for the voice, or speech, the centre for sight, and also that for sensation are marked. The frontal

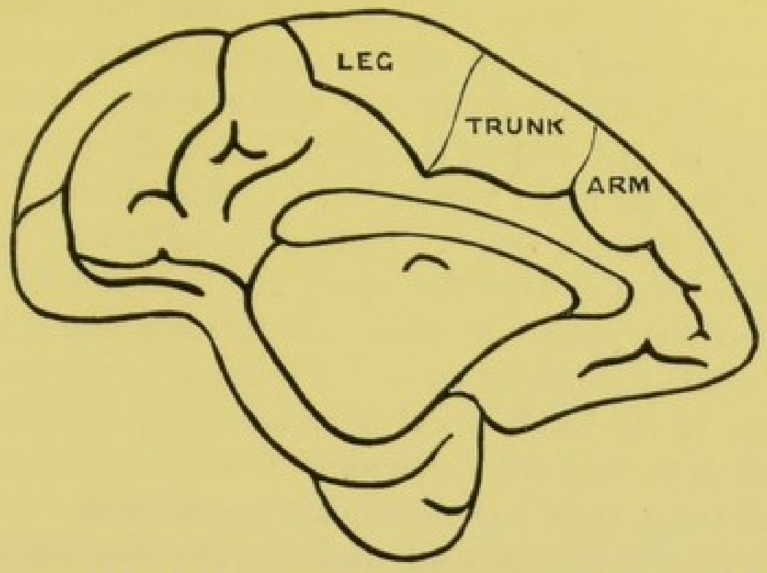


FIG. 57.—View of a lobe of the cerebrum from the longitudinal fissure. After Horsley and Schäfer.

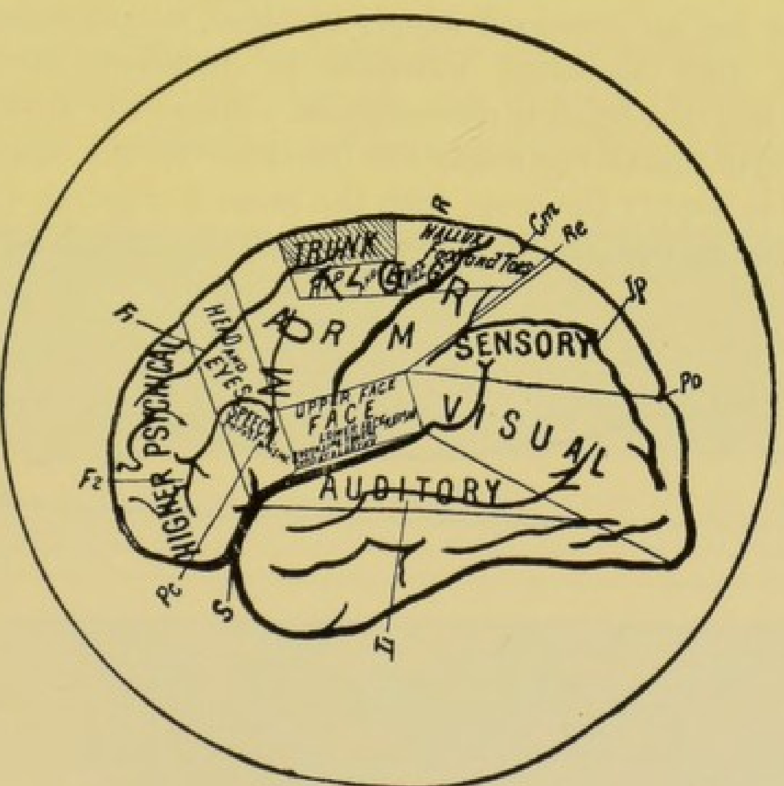


FIG. 58.—Cerebral cortex showing the distribution of function. After Osler.

lobes probably contain the higher centres, which are only brought into action after a long time, so long a time that their condition is not to be made out by experiment. To illustrate what I mean, I may remind you that if one man strikes another, number two may immediately retaliate and strike the other back. The centres for such action are low down, and the action may be almost reflex, hardly rising into consciousness. Instead of this he may go and lodge a complaint before the police. The centres for this are much higher, and the time wanted for such a complex act is much longer. Instead of doing this, however, within a few hours or days, the latent time between the action and reaction may extend to years, and in some men a blow of this sort would apparently excite no reaction at the time, but the memory of the insult would be treasured up for years, and ten, fifteen, or twenty years afterwards it might be repaid. The centres for smell, taste, and hearing are also marked.

Methods of Stimulation.—All these centres may probably be stimulated generally and locally. They can be stimulated generally by whatever will increase their nutriment. Wherever you get an increased supply of blood to any organ, you generally find increased nutrition or increased functional activity, and the brain is no exception. Mosso has shown that when a man thinks vigorously the blood leaves the extremities in order to supply the brain with the blood it requires, and you may stimulate the centres for the brain, both sensory and motor,

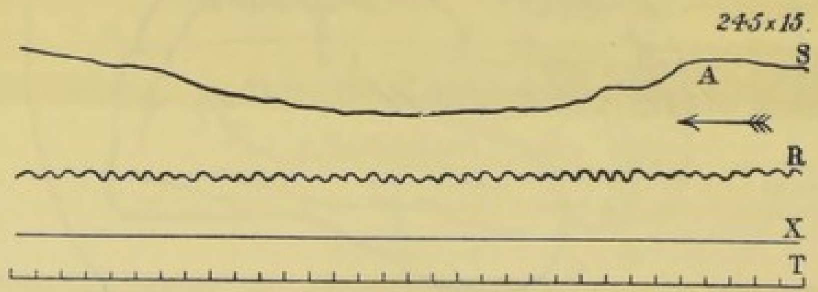


FIG. 59.—To show the contraction of the vessels produced during the process of multiplying 245 by 15. S, volume of left arm. A marks the point at which the calculation was commenced; after this point the pressure falls. B, respiratory movement of chest. X, abscissa. T, time line; every upright marks an interval of five seconds. (Mosso.)

by increasing their supply of blood. For this reason we find when men have got hard mental work to do they fall upon various plans for stimulating their brains. Some men when working will walk about; others, again, will lie perfectly quiet. These two methods of proceeding seem incompatible, and yet, if you take into consideration the different constitutions of the men who do these things, you will find that both are trying in different ways to increase the supply of blood to their brain. The men who walk about all the time they are thinking are exciting their heart by physical exercise, and thus driving more blood to their brain; the men who lie quiet are inducing more blood to flow to their brain by lessening the flow through the muscles and elsewhere. I daresay many of you may remember Mark Twain's experiences in his "New Pilgrim's Progress," where he got a horse so old and so feeble that it "wanted to lean up against a post to think." Now, you find that where circulation is feeble people want to lean up against a post to think, and if you ask them a question suddenly in the street, they do not answer you; they have to stop still and think. In them muscular exercise and mental exertion are incompatible.

Position.—Position has got a great deal to do with the supply of blood to the brain, and in men who are very tall, and in whom the circulation is not very strong, the best work may be

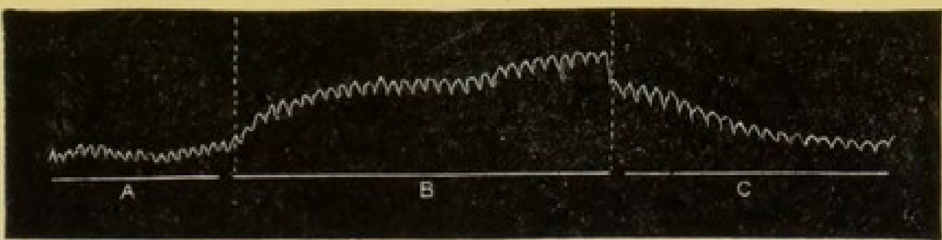


Fig. 60.—Tracing showing the increased circulation in the brain caused by inclining the head and body forwards. The tracing was taken by Brissaud and François-Franck from the parietal region of a woman who had lost a large piece of bone from syphilis.

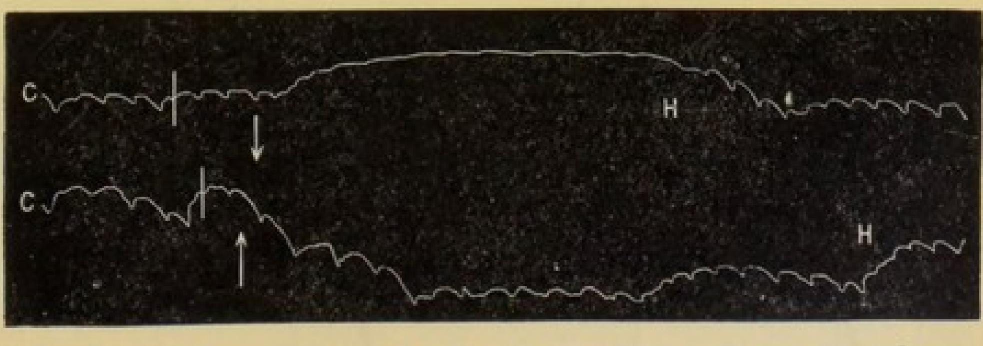


Fig. 61.—Tracings from the brain of a dog after trephining, showing the influence of position on the cerebral circulation. In the upper tracing the vertical line shows when the head of the dog was lowered, and in the lower tracing when the head was raised (Salathé).

done not by walking about while they are thinking, but by lying perfectly quiet, and in a peculiar position. There is one of our best-known writers who is very tall and not very stout. He writes admirably, but he has a very large and fine head and a somewhat slender body, which does not seem strong enough to supply it with blood. I was told that his method of writing was peculiar; that he lay down upon a sofa and wrote with his head low down. This statement seemed to me so interesting physiologically that I was not content to take it at second hand, and so I asked him one day if it were true. He then told me that he writes kneeling down upon the sofa, with his paper resting on the end of the sofa, so that his heart and head are nearly on a level. Thus he secures a free supply of blood to his brain, and although it is not usually carried out to the same extent as in this instance, yet the instinct of people generally has taught them to lower their heads when they are engaged in thinking. This is shown in the diagrams Figs. 62 to 65. Not uncommonly they rest their chin upon their hand, as in the diagram Fig. 66. When the circulation is weakened by the action of grief or other depressing emotions on the heart, the head is usually lowered still further, and the hands are pressed against the temples (Fig. 67). You may, therefore, stimulate the brain either by stimulating the circulation through increased cardiac action, or by increased supply of blood by position.

There are other ways of stimulating the brain, and one is by local dilatation of the vessels. You will find that in almost

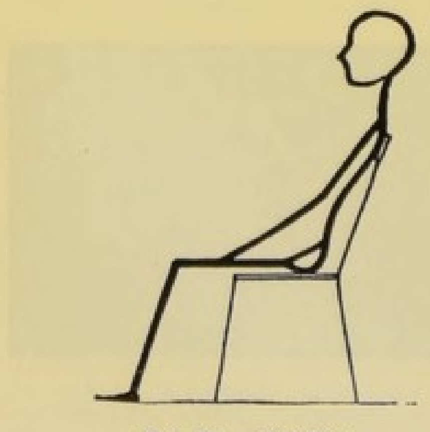


Fig. 62.—Attention.

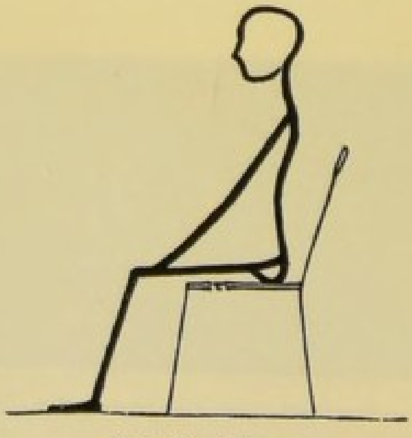


Fig. 63.—Interest

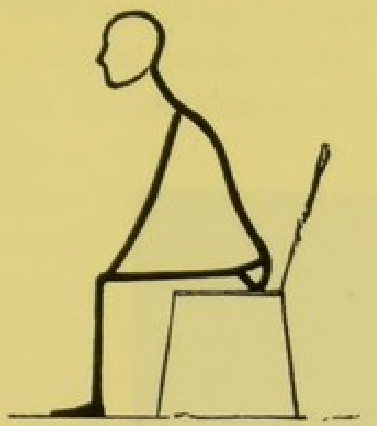


FIG. 64.—Eagerness.

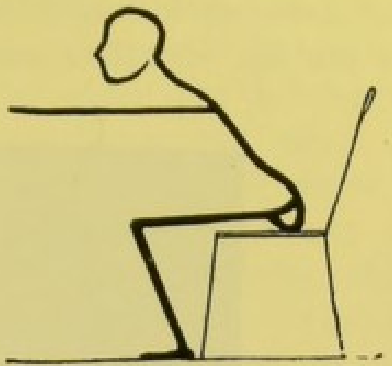


FIG. 65.—Excitement.

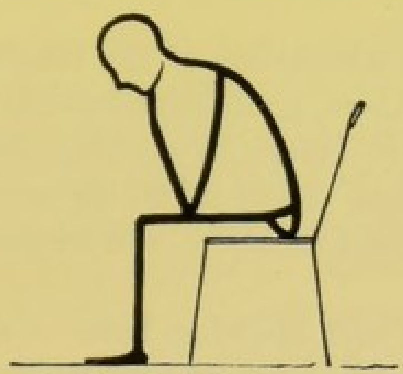


FIG. 66.—Reflection.

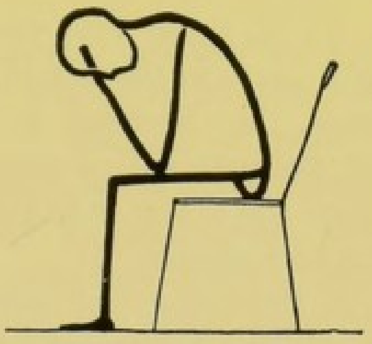


FIG. 67.—Grief.

every country people have hit upon some way of causing local dilatation of the vessels of the brain. Whenever people are puzzled they do something or other that seems to help them. If you ask an English rustic a question that troubles him, it is very likely that he will scratch his head, while another man will pull his moustache or beard. Another, again, especially in Germany, will slap the side of his nose with his finger. In all those ways you get a stimulus applied to some branch of the fifth nerve; and it would appear that stimulation of the fifth nerve, either outside the head or inside, tends to cause local dilatation of the cerebral vessels. Many writers, when they are puzzled and do not know exactly how to put the thing they want to express, stimulate the gustatory branches and the buccal branches of the fifth by taking something that has got a strong taste. For example, the late Lord Derby used to eat brandied cherries while he was engaged in his classical work; others, again, smoke cigarettes; others chew tobacco; while others eat figs, chocolate creams, or something of the same

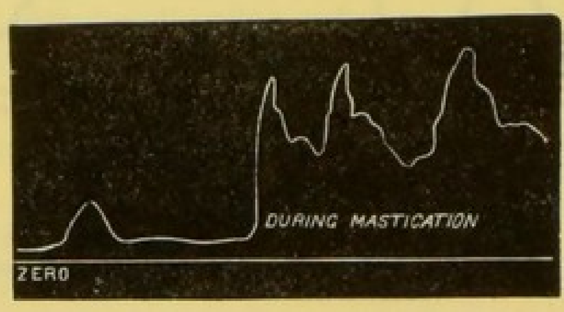


FIG. 68—Tracing to show the increased rapidity of circulation in the carotid of a horse during mastication. After Marey.

sort. In all those ways you get stimulation of the branches of the fifth nerve in the mouth. Others, again, stimulate the nasal branches, the Germans, as I said before, by striking the outside of the nose with a finger, some others by taking snuff. In all these ways you stimulate the fifth nerve and increase the cerebral circulation.

Now, the actions of sucking and chewing have a similar effect, and during sucking or chewing a very greatly increased supply of blood flows through the carotids. Chewing brandied cherries, for example, has the double effect of stimulating the sensory nerves and increasing the circulation through the brain by the muscular action of chewing. Sipping has got a very peculiar action indeed, and if you try for yourselves you

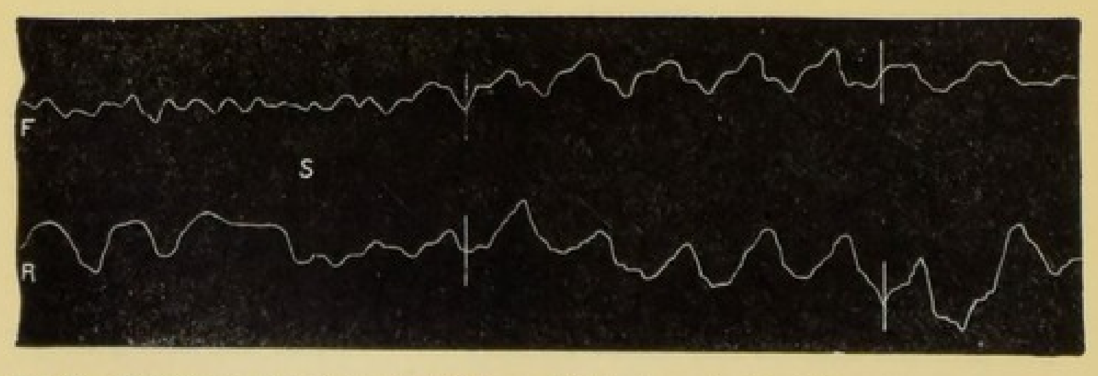


FIG. 69.—Pulsations of the fontanelle (F) in an infant six weeks old while sucking. R shows a simultaneous tracing of the thoracic respiration. The breast was offered to the child at the beginning of the tracing. At the time indicated by the third respiratory wave, which has a flattened top, the child began to take the breast. It will be noticed that the line of the tracing F rises, indicating increased circulation on the brain. After Salathé.

will find that if you sip a glass of water slowly it seems to stop the action of the vagus upon the heart, so that the heart beats very much more quickly than before. It is worth your while just to try it. Take a glass of water; put it down beside you; either count your pulse yourself, or, still better, get a friend to do it for you; then sip the glass of water very slowly, taking little distinct sips at a time, and get your friend to count the pulse during the time you are sipping, and you will probably find that the pulse-rate will go up perhaps one-fourth or even more. In trying it upon myself, my pulse-rate has been raised from 76 to over 90 by the mere action of sipping.

Stimulants.—You can now see that the question of stimulation of the brain is a somewhat complex one, and that the drugs which we employ as stimulants may act in a good many different ways. One of the most powerful stimulants that we have is ammonia, and this may be used in a good many different ways. One of the commonest is simply to inhale the vapour of ammonia or carbonate of ammonia, and this has often the effect of strengthening the circulation and of preventing fainting. Position has not only got the power of increasing the circulation and the mental power in a normal person, but it has also the effect of preventing failure of mental power or of sensory power in persons who are about to faint. One of the things to be avoided—and it is a thing commonly done by people who do not know any better—is to raise persons who are faint. You had much better let them lie quiet with their head down, because the flat position is the best way of bringing people round. In the surgery you will have occasion frequently to deal with people who are feeling faint, and I daresay many of you know the plan that is commonly adopted there, which is to let the patient sit down with his or her head between the knees, to bend well forward, and in this way you get a free supply of blood to the brain and prevent the fainting fit from coming on. If you raise the head suddenly, and more especially if you raise the whole body suddenly, you may get the blood remaining in the body, by its own inertia and not reaching the brain quickly enough, to maintain its functional activity, and so the person faints.

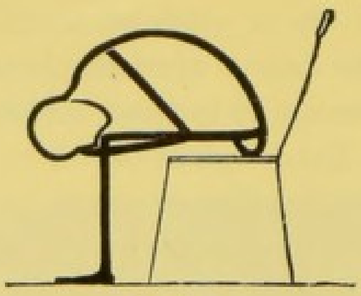


FIG. 70.

Before the introduction of chloroform, a curious plan was employed in Paris for causing temporary anæsthesia. They laid the man who was to be operated upon flat upon the ground. At either side of him they had three strong fellows, who at a given signal raised him quickly from the recumbent to the standing position. The head was raised quicker than the blood could follow it, and this temporary anæmia of the brain brought about a faint, during the continuance of which the operation was performed. It was proposed by the late physiologist, Dr. Waller, to produce anæsthesia not by simply raising the man, but by garotting him, simply putting the finger and thumb upon the carotid arteries, compressing them suddenly, and thus rendering the patient insensible; but the introduction of anæsthetics prevented either of these plans from having a very wide use. You must, however, remember the effect of sudden raising of the body, because it occasionally gives rise to symptoms which are very alarming to the patient. Some time ago a doctor consulted me about what he thought was an epileptic fit. One morning he had jumped up suddenly out of bed to pass water, and the first thing that he knew afterwards was that he was lying upon the floor of his bedroom, with the chamber-pot broken in pieces. He thought this was an epileptic fit, and he was in a state of great anxiety about it. It was not an epileptic fit, but it was simply a condition of syncope brought about by sudden jumping up from the horizontal to the upright position, the effect of this being still further increased by the diminution in the blood pressure in his abdomen through his emptying his bladder. In this case the nerve centres were less ready to react than they would have usually been because he had simply got up from his bed.

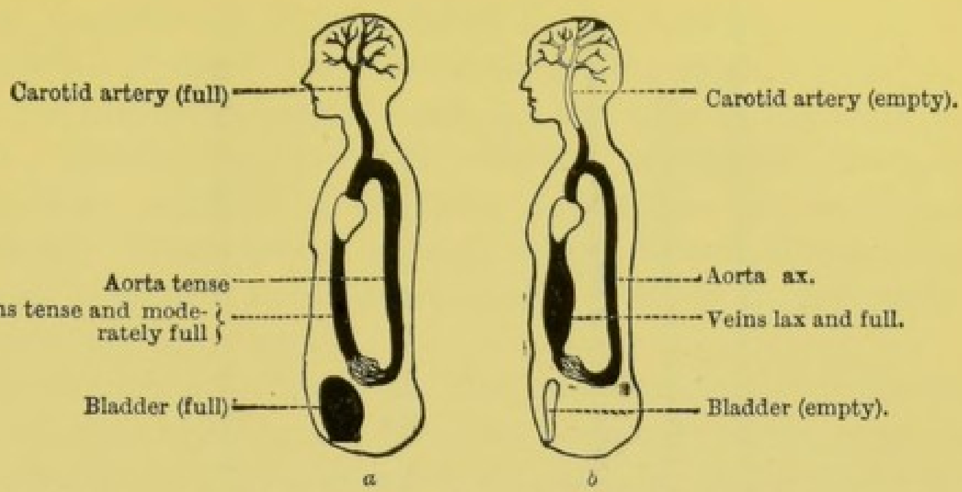


FIG. 71.—Diagram to show the effects on the cerebral circulation of rapidly emptying the bladder.

Another case that came under my notice of a somewhat similar nature occurred in a man in whom the nerve centres were dulled by the continuous use of opium. In these cases, all that you have to do in order to prevent the recurrence of such an alarming attack is to make the patient get up slowly, and to take care not to lessen the blood pressure more than usual by evacuating the bladder quickly when he is in this half-sleepy condition, especially if the drowsiness be due to a narcotic.

Ammonia has not only the power of stimulating the nasal branches of the fifth, but when taken into the stomach it stimulates the sensory branches of the vagus in the stomach, and thereby increases the heart's action. The same appears to be the case with alcohol, which, when taken by the mouth, stimulates the circulation, both generally and locally, in the way I have just explained. Taken into the stomach, it has a similar action to that of ammonia in increasing the force of the heart; when absorbed it has a further action, which is rather peculiar and complex. It may increase the circulation through the brain, and thereby act as a real stimulant by dilating the vessels, because alcohol does dilate the peripheral vessels, but at the same time alcohol, although at first a stimulant, is chiefly a narcotic: it lessens the activity of the brain-cells themselves by its direct action on them, even while, it may be, indirectly stimulating them by quickening the circulation. Among the

1. The eyes open widely, the pupils dilate, and head and eyes turn towards opposite side.

2. Extension forward of the opposite arm and hand, as if to reach something in front.

3. Movements of tail (and trunk)..................

4. Retraction with adduction of opposite arm.

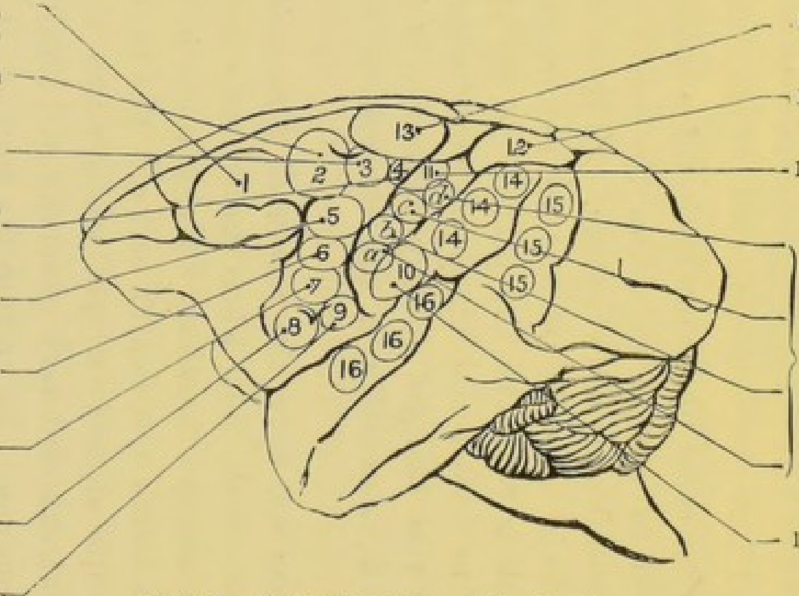
5. Supination and flexion of the forearm, by which the arm is raised towards the mouth.

6. Action of zygomatics, by which the angle of mouth is retracted and elevated.

7. Elevation of ala of nose and upper lip ......

8. Opening of mouth with protrusion of tongue.

9. Retraction of tongue................................



13. Complex movements of thigh, leg, and foot

12. Advance of the opposite hind-limb.

11. Retraction and adduction of opposite arm.

a, b, c, d, prehensile movements.

10. Retraction of opposite angle of mouth.

FIG. 72.—Brain of monkey. After Ferrier.

most powerful of all stimulants to the nervous system is strychnine or nux vomica, because this drug appears to stimulate not merely the spinal cord, but the cells of the brain as well. Another very powerful stimulant is absinthe. Perhaps there is no stimulant to the brain that is quite so powerful as absinthe. When given in large doses, instead of producing general depression and narcosis, as alcohol would do, it produces epileptiform convulsions.

Irradiation of Stimuli.—I have mentioned to you that the convulsions which start from the cerebral cortex may be accentuated by the condition of the medulla and of the pons, but if we stimulate any of the motor centres by an induced current, we find that the first indication of reaction is a limited contraction of some of the muscles. Supposing, for example, that we were to stimulate at 2 (Fig. 72), the first effect upon the animal would be that the hand would go slowly forward, and then if we stimulate at 4 it would be retracted, and at 5 still further retracted. But if we stimulate at 2 very powerfully instead of the three points successively, we notice that perhaps we should get from one point a double action: that we may first of all get the forward action, then the backward movement of the arm from the spreading of the stimulus from centre 2 to centre 4, and then, as the stimulus became stronger, we should get a general convulsion of the body. And in many cases of irritation of the brain centres from local lesions we find that an epileptic convulsion will begin, say in one hand, and spread to other parts of the body. As Ferrier has pointed out, an ordinary observation, which shows the radiation of impulses in common life, is the movement of the mouth which we see in children learning to write. When a child begins to write, it takes its pen, and with great labour and difficulty it forms its pothooks, but the intensity of the stimulation to the centres for the hand and fingers is so great that it almost invariably extends to the centre for the mouth as well, and you will generally see the child moving the corners of its mouth and lips all the time it is making its pothooks. You will often see adults doing the same thing in turning a screw.

Sedatives.—We may now pass from the effect of stimulants to the action of sedatives upon nerve centres. If, in experiments such as I have been describing, you push the anæsthetic a little further, you will find that no stimulation, however strong, applied to the cortex of the brain, will have any effect whatever; so that one may stop convulsions of cerebral origin by the use of anæsthetics. But in cases of epilepsy one is unable to keep up the action of an anæsthetic, and we generally use certain drugs which will lessen the excitability of the cortex. One of the most important of these is bromide of potassium, and this drug when given in large doses will lessen the excitability to such an extent that the convulsions which have previously afflicted the patient may be stopped. You may have to push it to a considerable extent, and, so far as I have been able to see, there is no danger from pushing bromide of potassium. Even when it is pushed so far that the patient is quite unable to keep awake, and even when this condition is continued for a length of time, no permanent injury follows. Bromide of potassium differs from many of the other drugs which act upon the brain in this respect, that it seems simply to dull the brain equally throughout. It probably takes the place of the chloride of sodium which would usually be present in the tissues of the brain, and slows the chemical processes by which the functional activity of the brain is kept up. Therefore the whole of the brain is, as it were, loaded alike, and no disturbances of the relative functional activity of different parts result from its use. In this way bromide of potassium acts not merely as a sedative or quieter of the brain, but also as a soporific or hypnotic; *i.e.*, it tends to bring about sleep.

Hypnotics and Soporifics.—Sleep is one of the most important things that a doctor has to consider, and I do not know that there is any condition more trying to a patient, or, indeed, more awful to behold, than a condition of absolute sleeplessness. Perhaps some of you may have heard that one of the most dreadful punishments that the Chinese have is to kill a man by want of sleep, and he generally dies in less than a fortnight from the time that the punishment begins. Bromide of potassium, like some other drugs, tends to produce sleep by lessening the functional activity of the brain-cells, but you may bring about sleep to a considerable extent by regulating the circulation. Perhaps this was best shown by some experiments by Friedländer on the action of isobutyl alcohol, in which, after a rabbit had received a dose of this alcohol, the experimenter was able, by reversing the position of the animal, to bring about sleeping and waking as he liked. When the head was put down the animal awoke; when the head was held up the animal fell asleep. When the head was held up the blood left the brain, so that it became anæmic, its functional activity became less than before, and the animal went to sleep. Perhaps one of the best expositions of sleeping and waking ever given was that of Mayow, who lived about 200 years ago, and in his time people said that all the functions of the body were carried on by what they termed vital spirits. These were supposed to be little imps that were present all over the body, and each one had its work to do; and "if," said Mayow, " a man takes a big dinner, all the vital spirits have to go down into the stomach in order to carry on digestion, and the man naturally goes to sleep, and cannot easily think; but "if the man will try to think after his dinner, and succeeds in doing so, the vital spirits will go up to his brain to do the thinking, leaving the stomach to its own devices, and consequently the food is not digested." If we substitute the word " blood " for " vital spirits " we have here a very good exposition of the modern physiological theories of digestion and of sleep.

We may induce sleep in two ways: either by lessening the flow of blood to the brain or by lessening the functional activity of the brain-cells. We may lessen the supply of blood to the brain by taking away any stimulus that tends to keep the blood flowing forcibly through the brain. Now, you know that when a person is cold the vessels of the skin contract, and the surface becomes pale. The blood that ought to have been in the skin has gone elsewhere, and if you inquire where it has gone you will very probably find that a good deal of it has gone to the brain; and when people are cold it is almost impossible for them to get to sleep. Cold feet especially seem to have a particular power to keep a person awake. All animals whenever they want to get to sleep have a way of covering up the abdomen, so as to keep the abdominal viscera warm. If you watch a dog you will see that he turns round two or three times before lying down, and then he curls himself up, so that his abdomen is kept warm. If ever any of you have travelled, let us say, in Switzerland, and stayed in some inn where there was very little covering to the bed, and the air was cold, you will have observed that after you had heaped all the clothes you could get over you, you doubled yourself up and brought your thighs against your stomach, so as to retain all the warmth you could. The position that one usually takes is somewhat as I show in the diagram (Fig. 73). Warmth to the

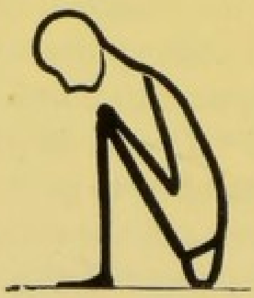


FIG. 73.

skin, and more especially warmth to the feet, is, therefore, especially useful as a hypnotic in tending to cause sleep. Warmth to the feet is easily applied by putting a hot-water bag or bottle to them; but occasionally patients appear not to like this, and it does not seem always to succeed. In some patients you may possibly get the result you desire by an entirely different proceeding. Instead of applying artificial warmth, you put the feet in perfectly cold water before the patient gets into bed, and with a rough towel or loofah you scrub the feet well while they are in the cold water, so as to increase the circulation, then, after the feet are taken out, dry them with a warm towel just before he gets into bed, and in this way a reaction is produced which consists in dilatation of the vessels and warmth of the feet, and then the patient gets to sleep.

The vascular district of the intestines is one of the largest in the body, and the position that I have just mentioned of drawing the legs up is sometimes rather tiresome.

You may often want to get the vessels in the abdomen dilated in order to induce sleep, and you may dilate them by the application of warmth either to the inside or the outside of the stomach. A very useful plan is to give the patient just at bedtime something to eat or drink, and a good form of food is something soft and farinaceous which will act like a poultice to the inside of the stomach. Some warm arrowroot or gruel, or even a glass of whisky-and-water, will answer, but note that you must not have either the gruel, the arrowroot, or the whisky too hot. You do not want to excite the beats of the heart, and if the food is too hot the heat may be transmitted through the stomach and through the diaphragm to the heart, and thereby excite the circulation, and so you do just as much harm by increasing the cardiac beats as you do good by dilating the vessels of the stomach. It is necessary to use a moderate temperature in order to dilate the vessels of the stomach without increasing the beats of the heart. Food, therefore, inside the stomach is frequently useful as a soporific. Warmth outside the stomach is also useful, and may be applied in the form of a hot fomentation, or a hot poultice, or a hot bag or bottle. But here again you have the difficulty that if your application be too hot you increase the beats of the heart, and thus you make the patient worse, and in practice it is found that better results are obtained from cold compresses than from hot fomentations. The cold compress simply consists of either flannel or lint wrung out of cold water, put over the abdomen, covered with oiled silk, and a bandage over all. In a short time the warmth from the body brings the piece of lint up to 98°, and this temperature remains the same during the whole of the night. The vessels of the intestine dilate under this application, and the patient gets to sleep. In cases of delirium you may find that a cold pack to the whole of the body is more useful than a pack applied to the abdomen alone.

A little while ago I saw it stated in one of the daily papers that a Frenchman had discovered that we were all wrong in sleeping with our heads on a pillow, that we ought to sleep with our heads down and our feet up; but this is absolutely contrary not only to physiological experience, but, what is still more important, it is contrary to the general experience of mankind through centuries, so that I do not know how it came to be put into the papers, except that the editors did not know what they were talking about.

Amongst the drugs which act upon the brain-cells, and thus lessen their excitability and bring about sleep, we have bromide of potassium, chloral, opium and its alkaloid morphine, sulphonal, trional, tetronal, paraldehyde, and a good many others of recent introduction. Chloral acts in two ways: it acts directly on the brain and indirectly through the circulation, for it not only lessens the excitability of the brain-cells, but dilates the vessels throughout the body and somewhat lessens the force of the heart's action. In this way chloral is sometimes a most useful drug, and combined with bromide of potassium sometimes brings about sleep when neither the one nor the other will do it alone. The disadvantage of chloral, of course, is that you do not care to use it in cases where the heart is already feeble. There is one class of case in which sleeplessness is one of the most obstinate symptoms, and that is in cases of chronic nephritis. In this condition the systemic vessels appear to have become contracted, and sometimes the heart is hypertrophied, so that there is a very high tension throughout the whole arterial system; the blood consequently pours through the brain with great rapidity, and it is very difficult for such persons to get to sleep. You may have in these cases to employ all the means I have detailed.

In cases of general debility and loss of vascular tone we sometimes find great sleeplessness at night when the patient is in the horizontal position, and drowsiness during the day when the patient is upright. Here the use of vascular tonics, such as digitalis, is useful by contracting the vessels and thus preventing the blood from flowing to too great an extent to the lowest parts of the body, and leaving the brain anæmic during the day, and allowing too much blood to course through it at night when the patient is lying down. Another cause of obstinate sleeplessness is an atheromatous condition of the carotid and cerebral vessels, where, the power of contraction being diminished, the blood flows freely through the brain, and the patient cannot get to sleep. In such cases large doses of bromide and iodide of potassium, combined with rest and massage, are amongst the most useful remedies one can employ. Sulphonal appears to have but little action upon the circulation, but it has a marked action upon the brain-cells, and it is one of the best narcotics. There are, however, perhaps, no drugs that have the same power of compelling sleep that morphine and opium have. The other drugs seem rather to induce sleep, but if any powerful stimulus is present, so that the circulation is kept active, and the brain-cells themselves are reflexly stimulated, they do not compel the patient to sleep. Morphine and opium, as a rule, soothe all the parts of the brain down, so that pain which was formerly present ceases to be felt, and the patient is able to get sleep. Here also we find that curious idiosyncrasies interfere with the usual action of the remedy, and a patient, instead of being put to sleep by morphine or opium, gets more and more wild and excited. Now I may mention a chance experiment that I made which may help you in treating some of your patients. One day I was giving a lecture upon a physiological subject, and had to operate upon a dog. It was important to get the dog under an anæsthetic as quickly as possible, or rather to get it to sleep before the lecture commenced. I injected about half a drachm of laudanum into a vein, expecting that the animal would, as usual, go off to sleep at once. Instead of this, it began to howl in the most awful way. I injected more laudanum, but the more I injected the worse the animal became. It was just the time to begin the lecture, and I was at my wits' end, when it occurred to me if I gave something else it might tend to make the animal sleep. I injected a dose of chloral, and in less than half a minute the animal not only went to sleep, but was completely anæsthetised, the two drugs seeming to aid one another's action. The same thing happens with patients. Sometimes if you give them opium alone you do not get the result you want, but with opium and chloral combined you may frequently obtain sound sleep.

There are some other drugs which are also serviceable.

Tincture of hyoscyamus is sometimes a useful narcotic and hypnotic. Two alkaloids, hyoscyamine and hyoscine, have been separated from hyoscyamus, and both may be used by subcutaneous injection. The dose of hyoscine is a very small one indeed; you generally give only about $\frac{1}{200}$th of a grain. I once gave $\frac{1}{100}$th of a grain, and I was rather alarmed at the result. The patient went so soundly to sleep that I was afraid she might not wake again. You should note that hyoscyamine and hyoscine are not the same; that the dose of hyoscine is much smaller than the dose of hyoscyamine. With regard to the motor centres, I ought to mention that occasionally you meet with a disease known as paralysis agitans, in which the patient is in constant tremor and constant movement. This is a most trying condition and very hard to treat. The only drug that I have seen do any good in this condition was hyoscine, subcutaneously injected in very minute doses of $\frac{1}{500}$th to $\frac{1}{250}$th of a grain. The injection of the $\frac{1}{250}$th of a grain completely stopped the tremors, so that the patient for four hours afterwards was able to play lawn tennis or billiards, although the tremors before it were so constant that he could not do anything whatever. What is rather odd, the dose of the drug did not require to be increased, but rather to be diminished, and when I last saw the patient the injection had been kept up for more than three years.

LECTURE 10.

Sleeping and waking—Cutaneous irritation, rigid and toneless arteries, over-fatigue, as causes of insomnia—Narcotics—Analysis of thought —Effect of drugs on mental processes—Alcohol and its impurities— Delirium tremens—Deliriants.

GENTLEMEN,

In last lecture we were discussing the action of drugs upon the brain, and more especially the action of hypnotics.

Natural Sleep and Waking.—There seems to be a natural provision in the body for alternation of sleeping and waking. During the waking hours man acts as an oxidising agent, giving off a larger amount of carbonic acid than corresponds to the oxygen he absorbs; during the night the process is reversed: he then acts as a reducing agent and gives off less carbonic acid than he absorbs oxygen. In the processes of life there seem, both during the day and during the night, to be formed certain alkaloidal bodies which have different physiological actions. During the early part of the day the substances that are formed have probably little or no action, but as the day goes on the products of tissue waste accumulate and exert a narcotic action, which becomes greater and greater until towards evening the person falls asleep; during sleep the processes of tissue waste are reversed, and instead of the products of oxidation products of reduction are formed. These have a stimulant, instead of a soporific, action. The amount of these in the circulation goes on increasing until, in the early morning, it is probably at its maximum. At the same time during the night the soporific substances are being excreted, so that, if you examine the urine, you find that it contains, especially in the early part of the night, soporific substances, whereas later on during the night the substances which are excreted have a stimulating action, and when injected into a frog will cause tetanus. We therefore seem to have a regulating apparatus in the body for waking us up and sending us to sleep.

Similar changes may be induced in alkaloidal bodies outside the organism. You all know that tea and coffee have a considerable power of keeping people awake, but it has been found that caffeine, when subjected to oxidation, becomes converted from a stimulant into a narcotic substance, the same change apparently being undergone by the caffeine as by the alkaloidal substances formed naturally in the body.

Effect of Irritation of Sensory Nerve-endings on Cerebral Circulation.—I mentioned to you that, in considering the relationship between the circulation and the brain-cells, we had, in addition to the cardiac action, to take into consideration the effect of dilatation or contraction of the vessels as well. For example, if a substance which dilates the vessels throughout the body generally and thus lessens the supply of blood to the brain has at the same time the power of stimulating the heart, we may have the cardiac stimulation increasing the circulation through the brain more than the dilatation of the vessels elsewhere reduces it, and so instead of diminished supply of blood to the brain and consequent sleep we may get increased supply and wakefulness. One sees this very markedly in cases where the patient suffers from eczema or some other skin disease, which gives rise to great cutaneous irritation and itching. The patient is unable to get to sleep on account of the itching. We find it also in cases where there is much pain; the person may be very drowsy indeed, but the painful stimulus will keep him awake. We use pain as a means of awaking a patient from a comatose condition. For example, when a patient has become completely comatose through the action of an overdose of morphine or opium, we use painful stimuli in order to awake him. We stimulate the skin so as to cause painful sensations and thus awaken him from the coma. Now, the condition of the skin may keep people awake, even although there is no pain and there is no itching. There seems to be a sort of irritability in the skin which prevents people from falling asleep, and we may remove this in many cases by simply sponging the skin with hot water or putting the patient in a warm bath, and more especially is this the case with children, in whom the skin is very delicate. Not unfrequently, however, you will find that, if the temperature of the skin be rather too high, patients will not fall asleep, and that, though a certain amount of warmth is necessary in order to get to sleep, yet too great warmth makes the patient restless and uncomfortable. And just as too little covering will prevent the patient from sleeping by keeping him cold, so too much covering may prevent him from sleeping by making him too warm. Occasionally people who are sleepless find this out for themselves, and when they cannot get to sleep while they are lying in bed, they will get up, and in their nightdresses will walk two or three times round the room, so as to cool themselves, and then, when they turn in again, they fall off to sleep.

Atheromatous Cerebral Vessels a Cause of Insomnia.—Rigidity of the vessels passing to the brain has a similar effect to that of want of tone. When the vessels are atheromatous, as they frequently are in elderly people, they may become hard and rigid like pipe-stems, and lose, to a great extent, their contractile power, so they are thus unable to regulate the flow of blood to the brain, and when the patient lies down, the blood rushes through the brain, and sleep becomes almost impossible. This is more especially the case if the atheromatous condition is associated, as it often is in gouty people, with high tension. In such cases the use of massage, with large doses of iodide of potassium, tends to lessen the rigidity of the arteries and render them more contractile, while the further addition of bromide of potassium quiets the brain-cells and allows sleep to come.

Insomnia in Anæmic Patients.—You can easily see that if the vessels of the brain have lost their tone, so that they cannot contract and regulate the flow of blood through the brain, patients will not be able to sleep readily, and we meet with this condition more especially in anæmic, debilitated patients. You will find lots of them coming to the surgery, and the complaint they make is that when they are about their work during the day they are constantly falling asleep or want to fall asleep, but the moment they lay their head down upon the pillow they are unable to go to sleep. Thoughts of all sorts seem to course through their brain, and they cannot get to sleep whatever they do. The way in which this condition comes about is simple enough. The heart being feeble and the whole of the vessels being lax, when the patient is standing upright or sitting in a chair, the blood accumulates in the lax vessels of the more dependent parts of the body, its return to the heart is imperfect, and thus the upper parts of the body, and especially the brain, are drained of blood. The brain then becomes anæmic, and the patient goes to sleep, like the rabbits I have already spoken of. But as soon as the patient lies down the blood flows back from the legs and abdomen to the heart. It has no longer to be pumped to the brain against the force of gravity, and as the cerebral vessels, in common with the others, have lost their tone, the blood pours freely through them, and prevents the patient from getting to sleep. In such cases what you require is to restore tone to the vessels, and this you are frequently able to do by the use of tonics, more especially by the use of digitalis, which braces up the vessels, and prevents the drowsiness during the day and the sleeplessness during the night. The action of this drug is to restore their tone to the vessels, so that they are able to contract and regulate the flow of blood through the brain when the patient assumes the recumbent position.

Probably all of you have noticed that if a person is very tired he cannot get to sleep. If he is simply tired he sleeps easily. Some years ago an author consulted me regarding sleeplessness. At that time this author was engaged upon a very important work, and it would have been very awkward if by the administration of narcotics I had disturbed the fine balance of the brain, because I might in this way have spoiled the book completely. So I did not like to give morphine or any other narcotic. It occurred to me that the author was very much overworked and overtired. So I thought that if I could bring the patient up from the stage of being overtired to that of being simply tired sleep would be obtained. I, therefore, prescribed tincture of nux vomica in doses varying from five to

20 minims, and succeeded perfectly. Sleep returned forthwith, and in some cases of overworked, nervous people you may find this remedy of very considerable service.

When the hypnotics the action of which we have been discussing have been given so as to cause sleep only, they abolish most of the functions of the brain nearly equally. They are not all equally abolished, because we have the phenomena of dreaming; but we need not enter into dreams here, except in so far as I may tell you that certain wines—and, I think, Burgundies especially—tend to increase dreaming, and occasionally you may lessen uncomfortable dreams by the use of bromides, which quiet down the cerebral hemispheres even during sleep.

Narcotics.—But a number of drugs tend to cause unequal disturbance of the functions of the brain, and to those we give the name of narcotics. One of the best examples of a narcotic that I can take is alcohol, and alcohol is especially to be chosen because it forms a specimen of a large class of drugs which act in various ways upon the brain according to the doses in which they are given. As I have already told you, alcohol, through its influence upon the circulation, may affect the brain as a stimulant; when taken into the stomach it may act as a hypnotic, producing sleep by its effect upon the vessels of the stomach and abdomen, dilating them and drawing away the blood from the brain. It may, however, act also, after its absorption into the blood, as a narcotic, first disturbing, then destroying, the functions not only of the brain, but of the other nerve centres as well. When absorbed into the blood it tends to cause, first of all, exhilaration, and this effect is to a great extent due to its anæsthetic or anodyne action. You find the actions of alcohol very well stated in the book of the Proverbs of Solomon. There you will find the first description ever given of the anæsthetic action of alcohol. A man says, "They beat me, and I felt it not; I will seek it yet again." He got beaten, but he got drunk first, and he did not feel the blows, and so he determined that the next time he was going to get beaten he would take strong drink again. Here we have the anæsthetic action of alcohol upon the body described. It is not, however, for its anæsthetic action upon the body that alcohol is so much sought after; it is for its anæsthetic action upon the mind in lessening the effect of painful stimuli. In the book of Proverbs, again, you find a description of this action: "Give strong drink unto him that is ready to perish, and wine unto those that be of heavy hearts. Let him drink and forget his poverty, and remember his misery no more." And it is to a great extent because strong drink and wine act as moral anæsthetics that they are so much sought after. If you look all through the animal kingdom, you find it is during youth that the jolly part of life comes. Look at the difference between a foal frisking about in the fields and the old cab-horse that can hardly get along. You can readily see that if by giving it whisky you could take away from the old cab-horse all the painful impressions of its life, and restore it back again to the jolly condition it was in when a foal, that the old cab-horse would be very happy to drink whisky at every opportunity. That is precisely what happens to men. The alcohol seems to render them to a great extent anæsthetic; they forget their present misery, and, more than that, they forget the memories of accumulated past miseries, so that you bring them back from the condition of men upon whom the cares of the world have already fallen to the condition of childhood or youth. And so it is that men seek alcohol, and that it is taken to such an enormous extent all over the world.

Hughlings Jackson has very well shown the relationship of the different parts of the nervous system to one another. In the spinal cord you have various centres regulating the movements of the body, while those in the medulla regulate those movements of the vital organs which are essential to life. In the brain you have the higher centres, some of which are little more than reflex, others of which are concerned with the highest mental faculties. In a rough diagram I have indicated by fine lines the highest faculties, which are the latest to develop and the first to go (Fig. 74), and the lower faculties, which are later in developing, are shown by thicker lines. As the centres get lower we may look upon the nerve elements in them as becoming more and more stable until we get down to the most stable of all centres, those for the circulation and respiration. One might

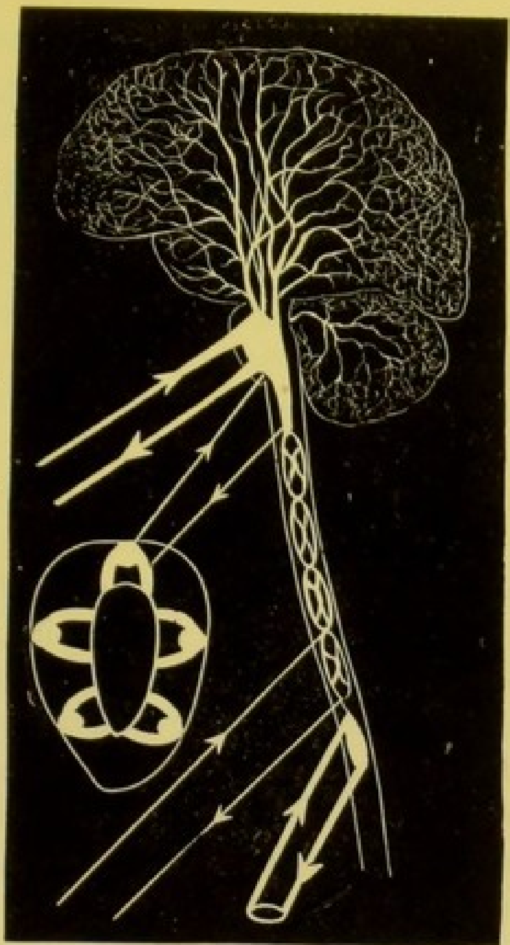


FIG. 74.—Diagram to illustrate Hughlings Jackson's views of the nervous system.

think that the centres for circulation and respiration would not be the most stable, but they are. They are the first to be developed, and they are the last to go. In the new-born child we have centres for respiration and circulation in full swing, and when the man is dying it is these centres that persist in their functional activity long after everything else is gone. We find the same thing in the development of mankind from the earliest germs. You know that it has been stated that the tunicates, or ascidians, were probably ancestors of man in his slow development during long geological epochs (Fig. 75). In the tunicates we have simply the body-cavity and an intestinal canal, into which not only food, but water, is taken. The water is taken in through the mouth, passes through the digestive tube, and is ejected through the cloaca. During its passage it tends to cause oxidation of the fluid which is circulating through the body-cavity. Now the movements of the cloaca and of the

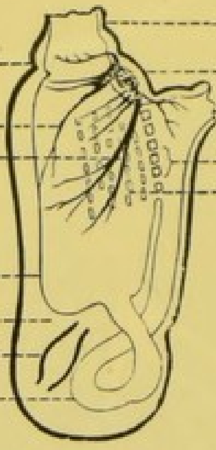


FIG. 75.—Diagram of an ascidian.

pharynx are kept up by a nervous ganglion which is situated between them, and is the centre for respiration. The respiratory centre, then, is the first part of the nervous system to appear in the course of evolution, and, although the cardiac ganglia may outlast it, it is the most stable part of the central nervous system, and the last to give way in death with the exception of the cardiac. The effect of alcohol appears to be, as it were, to shave off the nervous system layer by layer, attacking first the highest-developed faculties and leaving the lowest to the last, so that we find that a man's judgment may be lessened, though at the same time some lower faculties, such as the imagination and emotions, may appear to be more active than before, just as I told you that in the case of other parts of the nervous system when you remove inhibition you apparently increase the activity of a centre, and that the highest centres have an inhibitory action upon the lower ones. Thus you find that after a man has taken alcohol his judgment may be diminished, but he may become more loquacious and more jolly than before. Then after awhile his faculties become dull; he gets stupid and drowsy. This is the narcotic and anodyne action of alcohol. As a hypnotic it causes sleep; as an anodyne it removes pain; as a narcotic it also disturbs the balance of the faculties, so that the man is no longer able to judge things as he did before, but at the same time the man may be still able to walk. Later on it affects the motor centres, probably the cerebellum, so that the man is no longer able to walk, and reels whenever he makes the attempt. At this time, however, he may still be able to ride, and a man who is so drunk that he cannot walk and cannot speak may ride perfectly well. The reason of this is that at the time his cerebrum and cerebellum have lost their functional activity his spinal cord is still active, so that the mere reflex stimulus from the pressure of the saddle on the inside of his thighs causes contraction of the adductor muscles, and holds the man in his place on the horse. Later on the further anæsthetic action of the alcohol abolishes sensation, and its paralysing action destroys the power of the spinal cord, so that the man is no longer able even to ride; but still the respiratory centre in the medulla will go on acting, and it is not until enormous doses of alcohol have been given that the respiration becomes paralysed.

Now the convenience of alcohol as an object for study is that the stages in alcoholic poisoning are prolonged, so that you can subdivide each of them into a number of small portions, and, therefore, study each one more thoroughly. Ether and chloroform exert a similar action to alcohol, as do nearly all the substances belonging to the alcoholic series, only that in the case of these latter substances the various stages, instead of being widely apart and prolonged, follow close upon each other, and are shortened; and consequently we cannot study them so clearly as in the case of alcohol.

Analysis of Mental Action.—In considering the action of drugs upon the cerebrum, we must first of all examine the cerebral processes themselves, which, complex as they are, may be divided into three classes:—

1. The process of simple reaction.
2. The process of discrimination.
3. The process of decision.

Decision, for example, is sometimes a very long process, which requires very different times in various minds and under different circumstances, so much so that the length of the process sometimes becomes indefinite, and there are some people who never come to a decision at all.

The cerebral processes just enumerated are influenced not only by the constitution of the individual, the age of the individual, and the presence of disease, but also by the action of drugs.

Apparatus for Measuring the Speed of Thought.—We have here an apparatus by which the action of drugs upon these processes can be estimated. It consists of a pendulum, A (Fig. 76), which, as you see, has connected with it two elastic strings, *b* and *c*. One of these strings can be clamped when the pendulum has reached any point of the arc which it describes, in other words at any moment after it has begun to swing, and so we are able to read off by the position of the string, *b*, on the horizontal scale, *d*, against which it is clamped, and which is graduated in hundredths of a second, the exact time which has elapsed between the starting of the pendulum and the clamping of the string. The giving of the signal releases the pendulum, and directly the person whose reaction time is being tested sees or hears the signal he makes pressure upon one of the levers, B or C, and by this means turns the bar, *e*, and clamps the string, *b*. We are thus able to read off in hundredths of a second the time that has elapsed between the giving of the signal and the clamping of the string, or, in other words, between the giving of the signal and the completion on the part of the subject of some prearranged act, showing that he has perceived it. This, which is called simple reaction time, amounts in the case before us to $\frac{24}{100}$ths of a second. One finds that training in the use of the apparatus has a considerable effect upon the person who is using it: he reacts much more quickly than before. In the above case, we chose a signal which affected the hearing. We will now try to reckon the reaction time for a sight stimulus. By means of a simple mechanical arrangement, instead of making a sound by the release of the pendulum, we can alter the colour of one of the two paper discs, B′ and C′, which are placed in the frame just above the lever, which, upon being pressed, clamps the string. Directly the subject sees the colour of one of these discs change he presses the lever, and the pendulum string is clamped as before, and consequently the reaction time for sight deter-

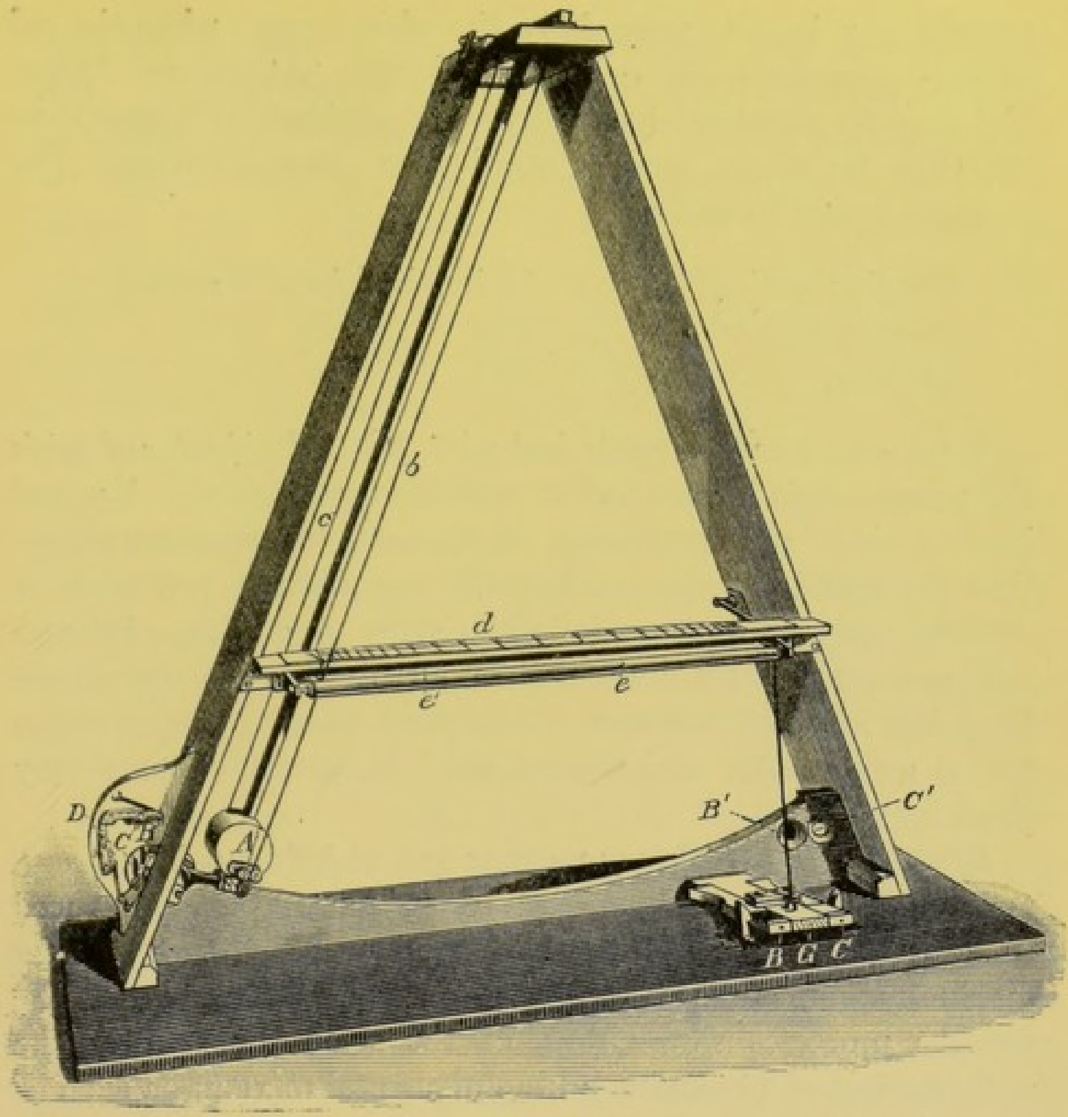


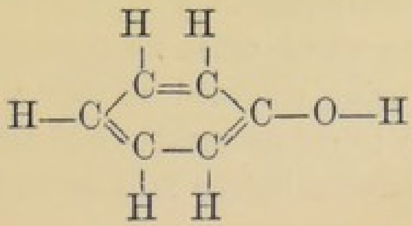
FIG. 76.—Apparatus for measuring the speed of mental processes.

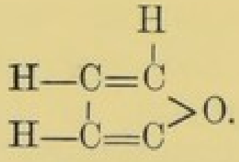
mined. We now get $\frac{18}{100}$ths of a second. We can further determine the time required for discrimination. By releasing the pendulum in a certain way, white or red can be made to appear at the discs instead of blue. You tell the subject if white appears to press, but if red appears not to press. This involves discrimination between the red and the white, but there is no difference in the action which follows upon the discrimination. The subject either presses or does nothing. We get here $\frac{24}{100}$ths. The next process is that of decision. Instead of pressing down the lever when one signal appears and not pressing it when the other appears, you have to alter the action, and this involves a longer process of thought. When the white appears you have to press down the white lever; when the red appears press down the red. We get now $\frac{34}{100}$ths and $\frac{38}{100}$ths. The time for decision is generally very considerably longer than the time for either simple reaction or discrimination. The averages would be as follows:—

Simple reaction	...	18 hundredths of a second.
Discrimination	...	24 „ „
Decision ...	...	36 „ „

These times vary a good deal with the individual and with the practice that he has had in working the machine. We find here, in these simplest forms of thought, the same variations that are found also in much more complicated processes of nervous action, for example in the game of cricket. When a man plays cricket for the first time, all his reaction periods are long, but after he becomes accustomed to play the reaction period gets shorter and shorter, until at last it becomes very short indeed.

Effect of Drugs.—These processes are all influenced by drugs, and one of the most common drugs by which they are influenced is alcohol. Alcohol increases the reaction time, the time for discrimination, and the time for decision. It makes all the nervous processes slower, but, at the same time, it has the curious effect of producing a kind of mental anæsthesia such as I mentioned before, so that these processes seem to the person himself to be all quicker than usual, instead of being, as they really are, much slower. Thus a man, while doing things much more slowly than before, is under the impression that he is doing things very much more quickly. What applies to these very simple processes applies also to the higher processes of the mind; and a celebrated author once told me that if he wrote under the influence of a small quantity of alcohol he seemed to himself to write very fluently and to write very well, but when he came to examine what he had written next day, after the effect of the alcohol had passed off, he found that it would not stand criticism.

Impurities of Alcohol.—Now the effect of alcohol varies a good deal with the impurities present in it. Alcohol itself is not so injurious as many of the other substances that are contained in it. A great deal of the injurious effect of alcohol has been attributed not to ethylic alcohol, but to the amylic alcohol or fusel oil that is very frequently present in it as an impurity. The amylic alcohol or fusel oil seems to have an injurious effect in rendering the mixture of ethyl and amyl alcohols more persistent in its action and tending perhaps to cause more headache afterwards. But the extraordinary effects that are sometimes seen to result from alcohol in the production of crime are probably not due to the simple admixture of amyl alcohol. Very few experiments have been made upon this subject, and almost the only ones with which I am acquainted are those made by Professor Curci, of Catania. You know that occasionally after drinking some men seem to be seized with a sort of maniacal attack, and they beat their wives, they half murder their children, and sometimes they murder them outright. Two years ago this subject attracted the attention of the legislature, and a commission was appointed to investigate it. The proposal was to lessen the injurious effect of alcohol, and thus to prevent crime, by bonding the whole of the spirit in the United Kingdom for at least two years, so that no newly distilled spirit should be drunk. The expense of this would have of course been enormous, and it was shown clearly that the time allowed was quite insufficient to enable such changes to take place in the alcohol as would deprive it of any injurious qualities which it might have when uew. The substances that probably have the greatest effect in producing crime are those which belong to the so-called furfurane series. You know that we have in chemistry the so-called open chains of carbon compounds, *e.g.*, ethyl alcohol, $H-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-O-H$; then we have enclosed chains of aromatic compounds *e.g.*, phenol, ; and between those two stand the intermediate bodies of the furfurane series. Well, furfurane seems to have the power of acting as an anæsthetic to a greater extent than alcohol has. It lessens the irritability of the sensory part of the nervous system to such an extent that it abolishes voluntary movement, and the animal remains motionless, although the power to move is still present, the motor powers at first not appearing at all impaired. The sensory powers are, however, greatly impaired. Now you can see that this very property would greatly enhance the value of an impure alcohol in the eyes of many people, especially of those who want to get rid of their misery, by the stupefaction it would cause. Furfurane has several compounds. It may be useful if I give you the formulæ for these bodies. They all contain the group which has been called by Baeyer "furfur," C_4H_3O—



The starting-point of the series is furfurol, or furfurane aldehyde, $C_4H_3OC—O—H$, which is obtained from bran, furfur meaning bran. We can regard this substance as derived from simple or formic aldehyde, H—C—O—H, by the replacement of the first H by the "furfur" C_4H_3O group. The formula for the alcohol of this series is $C_4H_3O—CH_2—OH$. This furfurane-alcohol, which for brevity may be called furfur-alcohol, may be regarded as methyl alcohol, CH_3OH, in which one of the hydrogens of the methyl (CH_3) has been replaced by the C_4H_3O group.

The furfurane alcohol has an action something like furfurane, but it is much more stimulating than furfurane, and it appears to cause in dogs that have taken it an amount of beatitude that seems almost indescribable. A dog, after receiving a dose of it, frisks about and seems almost unable to contain himself for joy, just in the same way as one sees a dog frisking about when he is going for a walk on Sunday morning after being confined all the week. After awhile, however, he begins to get uncertain in his legs, he falls down, rises again, and frisks about, but he falls down oftener and oftener, and at last he cannot get up at all, and then the poor creature seems to get a headache. He beats his head against the floor, and then he lies quiet for awhile and by-and-by gets up again all right. But the exhilaration that the dog has from this alcohol is throughout of a jolly, pleasant kind. The compound, furfur-aldehyde, or furfurol, has an entirely different action. The dog, after receiving a dose of it, seems to become almost like a rabid animal. He crouches in a corner, instead of moving about, and bites at anything that is held near him; seems, as Curci describes it, to have a certain sullen mania. This is the sort of thing that in a man would lead to crime. The furfur-alcohol ($C_4H_3OCH_2OH$) is not at all likely to lead to crime, but the furfur-aldehyde ($C_4H_3OC—O—H$) might very easily do so. One would, therefore, be inclined to advise that all spirit should be carefully tested for the presence of these substances, and that if found to contain them they ought to be freed from them. There are various other impurities in alcohol that change its effect. A number of those have been examined, and we do not quite know why the different kinds of alcohol act some upon the brain and others more upon the motor centres, but it is well known that sometimes one man will get drunk in his head, and another will get drunk in his legs. I have seen a coachman who was so drunk that he could not answer a question, and yet he could drive about the streets of London with the utmost confidence and certainty. He was drunk in his head. but he was not at all drunk in his arms. Another man may get completely drunk in his legs and be unable to walk about and yet have his head as clear as possible. It is said that the *moût*, or must, the unfermented or only partially fermented new wine, has the effect of making people drunk in their legs, so that in some parts of France during the vintage you not unfrequently meet with a person lying on the roadside quite unable to walk, but if you ask him the way to any place he will give you the directions as clearly as if he had taken no wine at all.

Delirium Tremens.—Alcohol is such an important subject that I propose to mention here its poisonous effects. When continued for a length of time, it gives rise to symptoms known as delirium tremens. The patient gets all sorts of visions, and thus the disease has got the name of "delirium." These visions very often have a most unpleasant character, so that it has sometimes been known by the name of "blue devils." There is also a marked motor affection, the hand and the tongue being very tremulous, so that it is known as delirium tremens. Delirium tremens is a disease that is very likely to give rise to suicide, and I must mention here an unwritten law of the Hospital for your guidance, because some of you will become house physicians or house surgeons, and you will want it some of these days. It is that if a patient comes to this Hospital in whom you suspect commencing delirium tremens you do not send him away, but you take him to the steward, who sees that if the man is not to be admitted somebody accompanies him home. The reason for that unwritten law is that several accidents have occurred which have given rise to a deal of scandal. Patients have come to St. Bartholomew's, they have been seen, prescribed for, and sent home, but on their way they have jumped over Blackfriars Bridge and been drowned. Delirium tremens is a complex condition. I had once charge of the delirium tremens ward in a hospital, and it seemed to me from what I saw then that a man may go on drinking to almost any extent without getting delirium tremens if he can eat at the same time, but if the man's appetite fails him he usually gets delirium tremens within four days. It does not matter what it is that destroys his appetite, whether it be that he gets pneumonia or a fever, or that he breaks his leg, or that he gets, what is most common, gastro-enteritis, or gastritis, simply from the irritation of the alcohol.

In treating patients with delirium tremens one of the first things to do is to get food into them somehow. Do it by the stomach if you can, but that is sometimes a difficult thing, because they frequently suffer from vomiting. If you cannot get in enough food by the stomach, then it must be introduced by the rectum. Eggs, milk, beef-tea, meat-juice, arrowroot, Benger's or other food, are all useful. Sometimes it may be necessary to give some brandy.

There is another point about delirium tremens that requires attention; and that is that such patients are sometimes apt to die suddenly, although there has been no apparent heart disease, so that, however trivial the case may seem, it is advisable to be guarded in your prognosis about delirium tremens.

When taken for a length of time alcohol affects the fibrous tissues; and more especially it affects the liver, where you get the connective tissue increased. At first the liver may be enlarged, but afterwards it grows smaller; the circulation through it becomes impaired, fluid accumulates in the abdomen, and dropsy occurs. In other patients alcohol seems to attack the nerves rather than the liver, and various paralyses occur throughout the body. The symptoms of pains, tingling, numbness, and finally paralysis are due to peripheral neuritis, the peripheral terminations of the nerve seeming to become inflamed through the continued action of the alcohol.

There are some other drugs which have also an action upon the brain somewhat resembling that of alcohol, but differing in a good many respects. They are ether, chloroform, and other substances belonging to the same series. Both ether and chloroform are sometimes used as substitutes for alcohol in order either to gain the feeling of brightness or to lessen mental pain, just as alcohol is used; so that people become chronic ether-drinkers or chronic inhalers of chloroform in much the same way as they become chronic drinkers of alcohol. Another anæsthetic is used just like alcohol, namely, cocaine, and still another, morphine. These substances all have an anodyne action, but they are popularly used less for the relief of bodily than of mental pain, to make men or women happier for the time being by allowing them to forget their misery and by bringing back the feelings of cheerfulness that they had when children.

Deliriants.—There are two substances which greatly disturb the equilibrium of the brain, viz., belladonna and cannabis indica, and which are therefore known as deliriants.

NOTE.—The modification of Mr. Galton's instrument (p. 193) for measuring the speed of mental processes was made by Mr. Groves at my request. It differs from other similar instruments in having an arrangement for decision. I believe it has not been elsewhere described.

LECTURE 11.

Action of drugs on the cerebrum, *continued*—Deliriants—Haschish—Anæsthetics—Carbonic acid—Nitrous oxide—Stages of anæsthesia—Alcohol, ether, chloroform, compared—Causes of death during administration of anæsthetics—Shock—Administration of chloroform—Danger from impeded respiration.

Gentlemen,

At the end of the last lecture we were discussing the action of various drugs upon the cerebrum, and I mentioned that there were two drugs which had the effect of disturbing the relationship between the different parts of the cerebrum to a very great extent, viz., belladonna and Indian hemp.

Deliriants.—These two are known also under the name of deliriants, because they give rise to a species of delirium. Belladonna produces delirium of a peculiar character. It is so-called active delirium, in which the patient desires constantly to move about and is exceedingly restless, and yet at the same time is languid. The reason of this is that belladonna has the double effect of stimulating the nerve centres and paralysing the peripheral ends of nerves. In consequence of its stimulating effect upon the motor centres, it produces the desire for movement, but in consequence of its paralysing effect upon the ends of motor nerves, it produces a feeling of languor and disinclination to move. This kind of delirium is very characteristic of belladonna, or atropine, and is to be noted more especially in cases where children have been eating the berries of the deadly nightshade (*Atropa belladonna*), and have been poisoned in consequence. It is sometimes important to notice particularly some of these minute details, because you may be called upon to diagnose between poisoning by belladonna berries and scarlet fever. In both these conditions a red rash appears, and the delirium may be attributed to either the one cause or the other.

Indian Hemp: Haschish.—Indian hemp is known under a variety of names, according to the mode in which it is prepared and according to the places from which it is got. One of the commonest names is that of haschish, and this name has given rise to the word "assassin." The assassins were men who, at the bidding of a leader, would penetrate anywhere and at any risk to execute their leader's commands. Frequently he desired them to kill particular individuals, so that in the Middle Ages, when a man was found dead in his tent in the morning with no trace of how he came by his death, except perhaps a dagger wound in his breast, it was usually concluded that he had been killed by one of this band, who were called assassins. They were under the leadership of an old Arab sheikh, who used to go by the name of "Sheikh el Jebel," the old man, or chief, of the mountain. It is said that this old man used to get those whom he proposed to enrol in his band up to his castle in the mountains, where they seemed to themselves to have entered into heaven. He led them to believe this by giving them haschish, and during the period in which they were under its influence they had extraordinary dreams, in which they enjoyed all the delights of the Mohammedan paradise. These dreams seemed to them quite real; and they believed that if they obeyed the commands of the old man he could again transport them at their death into paradise, where they would enjoy all those delights again, and so they were quite willing to face not only death, but torture, in order to do his bidding. Haschish, or Indian hemp, is not unfrequently used as a sedative to the intestine and to the brain, but you require to be rather careful in its use. The active principle of Indian hemp is of a resinous character, and if you prescribe tincture of Indian hemp along with water the resin is precipitated, and it may fall to the bottom, so that the last dose in the bottle may be much too large for the patient. You may sometimes also, in order to get a more decided effect, be tempted to prescribe Indian hemp in somewhat larger doses than you ought. In my own experience the maximum dose of the tincture of Indian hemp is 20 minims, and I have once at least brought on delirium in a patient by giving 25 minims three times a day. The dose of course varies with different individuals, but the maximum usually is 20 minims. From 20 minims I have seen no bad effect, but more than 20 may produce delirium, which is rather alarming to the patient's friends. The patient himself runs little or no risk from the effects of the haschish, because it does not seem to have any depressing effect, excepting in enormous doses, either upon the respiration or heart, and so the patient's life is in no danger.

Anæsthetics.—From deliriants we may pass to the effect of anæsthetics, substances which abolish sensation. Anæsthetics may be local or general. I have already mentioned some local anæsthetics when speaking of the effect of drugs upon the ends of sensory nerves. I then told you that cold is one of the most common and useful of local anæsthetics, and one of the most convenient ways of applying the cold is by means of the evaporation of chloride of ethyl. Formerly chloride of methyl was very much used, but it has lately been displaced to a very great extent by chloride of ethyl. In place of having the liquid in a clumsy bottle, we have it now in small glass flasks, which are covered at the end simply by a well-fitting cap. You unscrew the cap, invert the flask, and then as the fluid evaporates it drives a certain portion of the liquid out in the form of spray, which is easily directed upon any part of the body. Very soon the part becomes white and blanched as the spray plays upon it. Directly it becomes white it also becomes anæsthetised, and any operation may be at once commenced. It is advisable not to continue the application longer than is absolutely necessary, because if it be continued for too long a time, so as to completely freeze the tissues, local ulceration is likely to be produced. The space that is frozen by such an apparatus as this is very small, and so it is chiefly used for limited operations, such as opening abscesses, or perhaps more frequently for causing a limited local anæsthetic patch when you are going to put a trocar into the chest in aspirating for pleurisy.

Carbonic Acid.—Amongst general anæsthetics, the most universal is carbonic acid, and it is a merciful provision of nature that almost every individual as he passes out of this world passes out in a condition of anæsthesia. As the strength fails, and the respiration becomes feebler and feebler, carbonic acid accumulates in the blood; the nerve centres become dulled; the man becomes anæsthetic, becomes insensible to pain and to external impressions, and finally slips away. It is difficult, however, to use carbonic acid as an anæsthetic in cases of operation, because the space between the time when the cerebral centres are dulled and the time when the medullary centres, by which life is kept up, are affected is so small. So that when once the cerebral centres are affected the medullary centres become paralysed shortly afterwards, and there is therefore a considerable risk to life. Consequently we are unable to employ carbonic acid for the purpose of ordinary anæsthesia in operations.

Nitrous Oxide.—There is one gas which has an action somewhat similar to carbonic acid, and that is nitrous oxide. The appearances produced in a patient by the inhalation of nitrous oxide are, to a great extent, the same as those in suffocation. The patient becomes livid during the inhalation of the gas, but at the same time we find that the cerebral centres are paralysed much sooner than the medullary, and nitrous oxide, instead of being a risky, is on the whole a very safe, anæsthetic. When administered along with air, it has a stimulating action, and, on account of the lively nature of the stimulation which it produces in the brain, the mixture of nitrous oxide with air has been termed "laughing gas." I was unaware until some years ago that the same stimulation could be produced, not only by mixing the nitrous oxide and air previous to inhalation, but by the inhalation of air immediately after a small quantity of nitrous oxide had been taken. It is only when a small quantity of the nitrous oxide has been inhaled that you get this effect; you do not get it after inhalation of nitrous oxide for the purpose of producing anæsthesia. In taking pure nitrous oxide in order to produce anæsthesia, there seems, according to my own experience, to be very little stimulating action. Once when I was having it for the extraction of a tooth I was told to count 1, 2, 3, and so on, and I experienced no sensation until I had begun to count 12, and then I heard the dentist say, " It is all over." I had stopped between 11 and 12, and in the interval of unconsciousness between counting those two numbers the tooth had been extracted. There was no subsequent tendency to exhilaration, or to any mental disturbance of any kind. But some years ago, after I had been lecturing one day upon the effect of nitrous oxide, I went into the side-room and began to inhale the gas. A short time after the inhalation began, I experienced a feeling of warmth over the body, and then I thought, as there was a slight giddiness, I had taken enough, and I laid the mask of the inhaler down. In about half a minute or so afterwards, it seemed to me as if I were galvanised, as if an electric shock went up my back, and I became possessed with a spirit entirely apart from my own. I jumped up, laughed, danced, perfectly conscious of all that I was doing, but perfectly unable to restrain the movements. There were two or three men in the room, and it struck me at the time as being rather odd that they did not laugh. The effect of the gas passed off as suddenly as it came, and then I asked them how it was that they did not laugh at such an exhibition. They said: " We thought you were playing a joke, and a very bad one." If it had been a joke it would have been a very bad one, but the movements seemed to be altogether independent of my own will; and apparently this is what occurs during the inhalation of nitrous oxide mixed with air in the ordinary laughing gas. A good deal of dispute has arisen as to whether the effects of laughing gas are simply due to the absence of oxygen or to the presence of carbonic acid, whether the action is due to simple suffocation or whether the nitrous oxide has a definite action upon the nerve-cells of the cerebrum. This involuntary experiment of mine has shown me, to my own satisfaction at least, that there is a distinct action of the nitrous oxide upon the cerebral cells quite apart from any condition of asphyxia. Other experiments have also shown conclusively that the nitrous oxide in the lower animals has a distinct paralysing effect upon the cerebral cells, although no doubt its effect may be aided by asphyxia.

We have before us the apparatus that is generally used for the administration of nitrous oxide. It consists of a metal bottle, in which nitrous oxide is condensed under great pressure. In order that the supply may not run out during the continuance of an operation, two bottles are joined side by side, so that in case one should become empty the gas may be obtained from the other. To this bottle is attached a long indiarubber tube, ending in a mouthpiece. About the middle of the tube a large indiarubber bag is interposed, and the exit of gas from the bottle is regulated by a stopcock. This stopcock is provided with a flat plate, on which are some large projecting pieces instead of an ordinary handle. By means of this it can be opened and closed by the foot of the operator instead of by his hand. All that you have to do is to place the bottle on the floor and then put your foot upon the plate of the stopcock, when you can turn it one way or another with perfect ease. If there were no bag between the mouthpiece and the bottle, there would be, first of all, a risk of passing the gas under too great pressure into the lungs; and, secondly, the patient would not be able to inspire and expire the same gas, so that he would require a constant supply of nitrous oxide passing from the bottle. But when the bag is filled the patient is able to inspire and expire into it; as a result of this he inhales the same nitrous oxide over and over again, and thus a comparatively small quantity is sufficient to produce anæsthesia. As I turn the stopcock you will see the bag will slowly fill, and one must take care that there are no kinks in the tube. The mouthpiece is put before the patient's mouth; he can inhale the gas and expire into the bag, but there is an arrangement by which the amount of gas that passes in can be regulated, and if one so desires, the gas can be completely shut off, and the patient allowed to breathe pure air.

The disadvantage of the anæsthesia produced by nitrous oxide is that it lasts such a short time that it can only be used for short operations, such as the extraction of teeth, or the opening of small abscesses; the advantage of it is that it is so very safe. The number of accidents that have happened during anæsthesia by nitrous oxide is very small indeed. Sometimes it is advisable to have a more prolonged anæsthesia, and for this purpose nitrous oxide has been given along with ether, nitrous oxide first and ether afterwards. We have an apparatus which may be used either for ether alone or for ether combined with nitrous oxide; either ether is inhaled simply from the reservoir, or we can pass nitrous oxide through the reservoir, so that the patient inhales nitrous oxide laden with ether vapour. At any time the nitrous oxide can be shut off, and the operation can be continued with ether vapour alone.

Stages of Anæsthesia.—The three chief anæsthetics are nitrous oxide, ether, and chloroform. These three have an action which may be divided into four stages, like that of alcohol. The four stages are:—

1. The stimulant.
2. The narcotic.
3. The anæsthetic.
4. The paralytic.

In the case of alcohol we have all these stages very well marked and prolonged. There is (1) the stage where the actions of the man, either bodily or mental, seem to be increased—the stimulant—(2) the narcotic, in which the balance of the brain is disturbed; (3) the anæsthetic, in which the man no longer moves and no longer feels; and (4) the paralytic, in which the functions of the cerebral centres, of the spinal centres, and even of the medullary centres are abolished, so that a man may die from excess of alcohol. In the case of alcohol the stages are, as I have said, very much prolonged, and it is only when enormous doses have been taken that the paralytic stage is reached. Thus it seldom happens that a man is actually killed by the large quantity of alcohol he has taken. In almost all cases you find that even when the man has reached the anæsthetic stage, and is quite unable to move, to feel, or to think, when he is unable to do anything but breathe, he still recovers if left to himself.

Ether, Chloroform, and Alcohol Compared.—In the action of ether we have the same stages somewhat shorter than they are in the case of alcohol; and in chloroform the stages are shorter still, so that we have in regular order—

Alcohol,
Ether,
Chloroform,

alcohol very much prolonged, ether shorter, and chloroform much shorter.

Now, there is a further difference between chloroform and the other two: chloroform contains a halogen, viz., chlorine, and the addition of chlorine seems to be not only to render the action of the members of the alcoholic group of chemical substances more powerful, but to tend to make them more poisonous to protoplasm generally. Thus chloroform not only acts more quickly than the other two, but it has a greater tendency to act upon muscular fibre as well as upon the nervous structures, and herein lies one of its dangers. The advantages of ether over chloroform are that it has less power of paralysing; its action is slower, and consequently the paralytic stage is less easily reached than with chloroform, although more readily than with alcohol; and it exerts no injurious action upon muscular fibre.

The disadvantages of ether are that the stimulating and narcotic stages are more prolonged, so that a longer time elapses before anæsthesia is produced. Ether further exerts a stimulating action upon the secreting glands, so that more saliva is produced. The glands of the bronchi are also stimulated, so that more mucus is secreted in them; as a result, you may have not only saliva tending to choke the air-passages, but a quantity of mucus so great that it obstructs the bronchi during the operation. This irritant action of ether upon the mucous membrane of the air-passages may go so far as to give rise to bronchitis, or even pneumonia, and this may place the patient's life in danger. During the stage of narcosis also, the balance of the brain being disturbed, patients are very apt to be more talkative and to show themselves off to those surrounding them in a way which, in their full senses, they would not at all appreciate, so there are objections therefore to ether in this respect. One other disadvantage which I ought to mention is that it is awkward. You require to administer a much larger amount of ether than of chloroform; you usually want a special mask to administer it, and an apparatus which is bulky to carry about. Ether is also inflammable; and for all these reasons it is not so convenient, and is not likely to be used so much in general practice, as chloroform. Moreover, in cases where large numbers of men have to be treated it is quite impossible to have ether. After a battle, for example, ether could not be used for the production of anæsthesia, on account, first of all, of the time that it would take to put the patient under; secondly, of the difficulty of carrying the ether apparatus; and thirdly, of the quantity of ether that would be required. This objection applies still more strongly to warm countries; for example, in India, Africa, or other countries where the climate is very warm, you simply cannot keep ether. When I was over in Hyderabad doing some experiments on ether and chloroform for the Nizam, we found the greatest difficulty in keeping ether at all. The moment the appliances used to keep the stopper tight were taken off the ether began to evaporate, even although the stopper seemed to fit very well, so that in a few days we found the ether bottles empty. Another disadvantage is, as I have said, the inflammability of ether, and that is a point that must be borne in mind. You should always recollect that the vapour of ether is heavier than air. For example, if you happened to be operating on a table, and there was a fireplace in the room a little way off, the ether vapour might pass in a long stream down to the fireplace and thus be set on fire. If this should happen, the ether vapour would act just like a train of powder, and the flame would pass back along the line of vapour to the table, and might set fire to any ether that was there. You must always, therefore, remember that whenever you are dealing with ether vapour you must be careful to avoid fire. As an instance of this, I may mention what happened to a surgeon in Germany. He had just completed an operation for ovariotomy, and had closed the wound and painted its surface with collodion. He then took a candle just to see that everything was all right, but he forgot that collodion was a solution of gun-cotton in ether. The ether vapour took fire, and the patient was burnt to death. I had myself in one case a narrow escape from a very bad accident indeed. It was a patient who was affected with what I thought to be pleurisy, or rather empyema. I wished a surgeon to operate upon this case, and he proposed to use ether. I objected to the use of ether, because the cautery was likely to be employed. It was very fortunate that I did raise this objection, because when the operation was performed the supposed empyema turned out to be a curious dermoid cyst, a condition that I think has never been seen before during life, and only once or twice been discovered after death. After this dermoid cyst was cleared out, it was found to communicate directly with the trachea, and if the patient had been inhaling ether the use of the cautery would in all probability have simply blown her up completely. The whole of the ether vapour in the lungs would have taken fire, and the patient would have been killed

Chloroform has certain advantages over ether, but has also certain disadvantages. Amongst the advantages are its convenience. It is so easy to carry about; there is no apparatus required. All the apparatus that you want is a little bit of lint, even a pocket-handkerchief will do, and if you have a dropping bottle so much the better, but it is not necessary, and with a little care you can easily let the chloroform fall a few drops at a time upon the lint or handkerchief laid over the patient's nose. Again, the bulk of chloroform required to produce anæsthesia is much less than that of ether. Chloroform can be used in any warm climate, whereas ether cannot. Another convenience is that the periods of stimulation and narcosis are very much shorter than they are in the case of ether, and, therefore, anæsthesia is produced in a shorter time and with less excitement. There is also less irritation of the salivary glands and of the mucous membrane of the trachea and bronchi, so that you are not likely to get either profuse salivation, tending to choke the patient, or profuse discharge from the bronchi, leading to bronchitis afterwards. It has also a more agreeable taste than ether, so that chloroform is upon the whole very much more convenient and pleasanter to use than ether.

The great disadvantage of chloroform is that the paralytic stage is reached more quickly and is more complete than in the case of ether. In cases, therefore, where the heart tends to be feeble, chloroform is fraught with greater risk than ether. In considering the risks we run by the use either of ether or chloroform, we have to think of not merely the dangers which are due to the action of the anæsthetic, but of those which would arise from an operation without an anæsthetic at all.

Causes of Death during the Administration of Anæsthetics.—Many cases of death during operations have been recorded, and now-a-days these are all put down to the anæsthetic, whereas, in truth, a very large proportion of them are not due to the anæsthetic, but to the operation. I do not know whether any of you ever saw a man die upon the operating table. I did once, and a very unpleasant sight it was. It was a man who was having the supra-maxillary bone removed for malignant disease, and the whole of the orbit was exposed. On account of the risk of blood running down into the trachea and choking him during anæsthesia, he only had a few whiffs of chloroform at the beginning of the operation, just enough to allow the preliminary incision to be made. The whole of the rest of the operation was conducted without any anæsthetic whatever, and that man died upon the table from the shock of the operation.

Shock.—If you look at the old books on surgery you will find that men died very frequently from shock before the introduction of anæsthetics, and if you compare the descriptions there given with the descriptions of the operations now you will, I think, see that a great number of the deaths occurring during operations now are not due to the anæsthetic, but to shock, and until people begin to pay more attention to shock as the real cause of most deaths during operations, instead of attributing them all to anæsthetics, we cannot hope that deaths will become much fewer than at present. A man is not a horse because he happens to be born in a stable, and a death is not necessarily due to an anæsthetic because it happens to occur during anæsthesia.

Deaths from shock are very much fewer than they used to be, but they still occur. Shock may be induced in various ways.

It may occur simply from mental emotion, and a man may die suddenly without any injury whatever, as, for example, in a case that occurred here about three months ago. A man came in to see his father, who was mortally ill, in one of the wards of this hospital, and after the visit went out of the Smithfield gate and dropped down dead, before he got half-way to Holborn, simply from mental emotion. Thus there was a post-mortem examination of the father and son upon the same day. The father died of disease in the hospital; the son died of emotion in the street about 100 yards outside the hospital gate. We may get shock also from a blow. For example, a blow upon the abdomen may kill a man instantaneously, and yet on post-mortem examination you may find absolutely nothing the matter with him. There is no apparent cause for death, and it is simply the result of sudden nervous shock from the blow affecting the solar plexus. We may get shock, however, from irritation of the throat also. I was a good deal astonished in looking through Casper's "Handbook of Forensic Medicine" to find that more than one-half of the people who die from falling into water are not really drowned; they die, not from suffocation, but simply from shock. The same thing occurs when a person is killed by hanging or strangling. We generally suppose that such persons are suffocated, but this is a mistake; most of them die from shock, and not from suffocation. The effect of sudden pressure upon the larynx and trachea is to cause reflexly through the nervous system a sudden stoppage of the movements of respiration and of the heart. It is not that the respiration is obstructed while the heart goes on, as is usual in cases of simple suffocation, but the heart and the respiration stop together.

I think I mentioned to you that pressure upon the vagus had been proposed as a way of producing anæsthesia; that when both vagi are suddenly compressed a man simply drops and becomes unconscious. If the pressure be at once removed he recovers, and while he remains unconscious his respiration and circulation begin again, but if the pressure be kept up the respiration and circulation may remain permanently paralysed.

Now the administration of an anæsthetic tends to lessen shock, and you will find an interesting story in one of Leslie Stephen's books of a guide who one day got very drunk and walked over a pass in the Alps which was very narrow. The road in its most dangerous part was guarded by a railing, but the railing stopped rather short at each end of the narrow place. The consequence was that the drunken guide when he came to the end of the railing, instead of walking along the road, walked over the precipice and fell nearly 100 feet. He was picked up, and was not very much the worse, and the advice that Leslie Stephen gives is that if you are going into places so dangerous you had better not get drunk, lest you fall over, but if you are going to fall over you had better get thoroughly drunk,* so as to avoid the shock that might otherwise come on. I have only once seen a similar case. A man jumped over the Dean Bridge in Edinburgh, which, I should think, is a good deal over 100 feet in height. He landed on the rocky bed of the small stream which runs underneath, and there would not be much over a foot of water to break his fall. He only broke both thigh-bones, and was taken up without experiencing any dangerous shock. I saw him a fortnight afterwards hopping about on crutches, and he got all right. He was very drunk when he fell over; and the anæsthesia produced by the alcohol had greatly lessened shock. Other anæsthetics have a similar action, but it is only when the anæsthesia is pretty complete that shock is abolished. In the preliminary stages, when anæsthesia is coming on, or in the later stages, when it is passing off, you may again get shock. I think it would be interesting for you to look up the cases of deaths during anæsthetics, and you will find that a very small proportion occur during the height of the anæsthesia. It is just as the patient is going under, or just as the patient is coming out, that death takes place; but while the patient is thoroughly under you very rarely hear of any accident whatever. These times of partial anæsthesia, so to speak, are just when shock tends to make itself felt. During the thorough anæsthesia you may get paralysis of the heart or of the respiration by the action of

* Leslie Stephen : "The Playground of Europe," p. 87.

the anæsthetic itself, and if chloroform especially be pushed too far, so as to stop the breathing, you may have a certain amount of risk. So long, however, as one notices the respiration, and begins artificial respiration directly natural respiration stops, one rarely gets any harm whatever from the anæsthetic itself. It seems to me that this points very clearly to *shock* as the chief cause of death during anæsthesia, and the question arises how we are to prevent it.

Administration of Chloroform.—Now, there are two ways in which you may give chloroform with almost perfect safety, and these two ways are utterly different. One of the best animals for experimenting upon with chloroform is a rabbit, because a rabbit is peculiarly susceptible and is very apt to die from the administration of chloroform, so that you learn to be exceedingly careful in giving it to this animal. If you give the chloroform very gently indeed, gradually increasing the strength, you will find the rabbit will go over without any trouble whatever. But there is another way, and that is the one used by Pasteur in chloroforming his rabbits for inoculation with hydrophobia. The gentle method takes a good deal of time, but Pasteur's method is a very rapid one. He simply takes a handkerchief, soaks it with chloroform, claps it to the rabbit's nose, and holds it there; for nearly a minute the animal does not breathe at all, then it takes one or two deep inspirations, it falls over unconscious, and is completely anæsthetised. And you will find that men who have worked practically at anæsthesia divide themselves entirely into two camps: those who hold that chloroform should be given diluted, and the strength of it increased very gently, and others who say, "Cram it on: there is no danger whatever." And those who follow either the one or the other of these plans fully do not seem to come to grief; those who come to grief are the men who use a mixture of the two methods, sometimes applying the chloroform gently and at other times pushing it without sufficient care. I suppose the reason of this is that by following either of these methods you get in the one case thorough anæsthesia without shock; in the other, if you get shock at all, it is induced at the time when it can best be borne. If you apply the chloroform very gently you get no shock whatever, and, oddly enough, this may be seen not only in animals, but in plants. Observations upon this subject were first made by the late Sir James Simpson, and, I think, were recorded by him in the "Lancet" for 1842. Although these experiments are fully detailed, they seem to have been forgotten, and I have seen no reference to them in any of the recent works upon anæsthesia. The experiments were performed upon sensitive plants. As you know, if you touch the leaves of a sensitive plant, the leaflets at once fold up together, and then the leaf falls down upon the stalk. Sir James Simpson found that if the sensitive plant (*Mimosa pudica*) is put at once into strong chloroform vapour the leaflets shut up, and finally the leaf falls down, just as if you had irritated it in any other way. The chloroform acts, in fact, as a strong irritant to the plant. If, in place of applying strong vapour, you apply very dilute vapour, it apparently has no action at all upon the plant, but if you touch the leaflets after the vapour has been applied for a length of time you find they are no longer sensitive. Therefore we see that strong chloroform vapour acts as an irritant before it produces anæsthesia of the plant; the diluted chloroform vapour does not produce any irritation at all, but simply produces anæsthesia. The same occurs in the rabbit: diluted chloroform vapour causes anæsthesia without irritation, but if you clap the handkerchief soaked in chloroform to the rabbit's nose, you irritate the vagus reflexly through the 5th nerve, and thus stop the heart and the respiration for about a minute; after that the rabbit takes a breath or two, and the strong chloroform vapour anæsthetises it very quickly. But in this method of giving the anæsthetic the strong chloroform vapour acts upon the organs of the rabbit before they have been influenced at all by the anæsthetic. It would thus appear that there is comparatively little risk in giving chloroform vapour in a concentrated form at first, or in giving it in a very dilute form, but if you give it very dilute to begin with, and then cram it on at intervals, you may get very serious results.

I believe, however, that the main thing to do is to attend to the respiration, and to be very careful that this is not interfered with by position, or by any obstruction to the movements of the chest, or by anything in the nasal passages or in the throat.

Dangers from Impeded Respiration.—Position is a very important factor in causing serious results, and not unfrequently deaths have occurred when the patient has been moved from one position to the other. During the drawing of a patient down from one part of the table to another, as, for example, in preparing a patient for lithotomy, death has occurred while the patient was being removed. Further, if the back is to be the seat of the operation, the patient is often during the anæsthesia laid upon his chest; in this position the respiratory movements are hampered by the pressure of the body, much more so than in the dorsal position, and respiration under these circumstances is very apt to cease. Respiration may be greatly impeded by the pressure of clothes, and I have seen expansion of the chest rendered almost impossible by the arms of two strong dressers who were holding the patient down. They linked their hands across his chest and held him down forcibly, so that he could hardly breathe. Tight lacing is a very dangerous thing in the administration of anæsthetics, because the respiratory movements are by it impeded to quite an extraordinary extent.

But the greatest risk of all arises from the presence of foreign matters in the larynx and in the trachea, or from spasm of the glottis caused by irritation somewhere about the top of the windpipe or about the larynx. Spasm of the glottis may be brought on by strong irritation of the nose, *e.g.*, by inhalation of the vapour of strong Liquor Ammoniæ, and possibly in some cases the deaths that have occurred just at the beginning of the inhalation of chloroform have been due to the chloroform containing a quantity of irritating vapour, which has acted upon the nose and caused spasm of the glottis. It may also be brought on by irritating matters about the root of the epiglottis, or about the larynx, and these matters are likely to be either blood which has flowed into the back of the throat, or mucus, or, what is still more likely, food which has been regurgitated from the stomach. Spasm of the glottis is, I think, one of the great risks towards the end of the operation. In order to prevent it, one requires to be careful to have the head of the patient in such a position that any food or solid matter that is in the throat can pass out readily; this is easily effected by turning the head a little to one side. In order to prevent the regurgitation of food, it is usual, if possible, to give the patients little or no food for several hours before the operation. A very good plan is to give them a little beef-tea or a little brandy, as by this means the vital powers are prevented from falling very low. The best time of all to operate is the morning, and you will find that when men are able to choose their own time for operating they generally choose the early hours of the morning, when the patient is refreshed by sleep, and they give no food before the operation begins.

LECTURE 12.

Chloroform anæsthesia, *continued*—Death *during* anæsthesia and death *from* anæsthetics—Cause of death during chloroform anæsthesia—Artificial respiration—Junker's inhalation apparatus—Self-inhalation—Inhibition—Hypnotism—Faith-cure—Lourdes—Homœopathy—Mattei system—Antispasmodics—Action of drugs on organs of special sense—Conjunctiva.

GENTLEMEN,

At the end of my last lecture I was telling you how very important it is to prevent the entrance of any foreign substance into the trachea during anæsthesia, and that to this end one requires to be very careful about the position of the patient during the administration of chloroform and about the giving of food beforehand. In order to lessen the risk of food getting from the stomach into the trachea, it is advisable, if possible, to operate with the patient's stomach empty. This is not always possible; but if you can arrange for the patient to have no food for some hours beforehand, do so by all means, for if there is food in the stomach you require to be extra careful in the use of anæsthetics.

Administration of Chloroform.—Now, the position, the food, and the attention to clothing that I have already mentioned have all one common object, viz., that the respiration shall not be interfered with. But there is another way in which the respiration may be interfered with, and it is your duty specially to avoid this also, I mean the possible suffocation of your patient either by holding the cloth too tightly before the nose, or by using vapour so strong that he is unable to breathe. If you will look up Snow's work on chloroform, you will find some very interesting notes recorded there. Amongst the cases of death at the beginning of the operations, you will notice that many patients said, "I choke," and that immediately afterwards they fell dead. This is not the ordinary mode of death from an overdose of chloroform, but it is the kind of death that one usually finds from shock due to pressure on the respiratory passages, or interruption of the progress of air through them. So that you must not kill your patient by suffocating him by pressure on his nose, throat, or chest, nor must you choke him either by giving him chloroform vapour which is too strong, so that he is unable to inhale it without getting spasm of the glottis, or by using chloroform which contains such irritating products of decomposition as to cause spasm of the glottis itself. Both of those risks are to be carefully guarded against. It is easy to guard against the risk of giving too much chloroform vapour if you are thinking about it, but every now and again a man is tempted to give too strong chloroform vapour for the reason that during the operation he has allowed the patient gradually to come out of the anæsthetic. The patient begins to move; the surgeon cries, "Keep him under;" and the man who is administering the chloroform, in a hurry, throws a lot of it at once upon the sponge or inhaler, and puts it down over the patient's nose. This risk is not so likely to occur at the commencement of the operation, for then everybody is quiet, and a few minutes more or less make little difference. Consequently the anæsthetist is not tempted to give chloroform in this hurried way, but gives it quietly and gradually, without throwing a large quantity upon the towel at once. The consequence of this concentrated chloroform vapour being held so closely before the nose probably is that the patient feels suffocated, struggles, and then, after holding his breath for a length of time, takes a very deep gasp indeed, thus inhaling a large quantity of almost pure chloroform vapour into the lungs, and as a result of this sudden collapse may occur.

Risks during Administration.—Two great risks during the administration of chloroform, besides those mentioned in my last lecture, then, are:—(1) shock, from excessively concentrated chloroform vapour drawn into the lungs in great quantities at once; and (2) actual suffocation, due to the position of the patient, or to the pressure upon him by clothes or the hands of assistants. Chloroform vapour pure and simple is not nearly so dangerous as chloroform vapour along with carbonic acid, and carbonic acid in itself will sometimes produce stoppage of the heart, such as has been attributed to chloroform. Now a great discussion has been raised regarding the mode of action of chloroform in causing death, and there are two great camps, one of which holds that the heart is the organ through which death is usually produced ; the other holds that the respiration is the function which is usually first destroyed. One camp holds that the duty of the administrator is to watch the heart; the other camp holds that his duty is to watch the respiration.

Cause of Death under Chloroform.—A good deal of dispute exists regarding the mode in which chloroform causes death, and this is likely to exist until people clearly distinguish between two things which are entirely different, viz. :—1st. The way in which chloroform, ether, or other anæsthetics cause death ; and 2nd. The causes of death during anæsthesia. It is curicus to note how these two things, utterly different as they are, are completely confused in people's minds, and one is reminded of Mark Twain's calculation regarding the comparative frequency of death in bed and in railway carriages. Statistics show that the frequency of death in bed, as compared with death in railway carriages, is as several hundred thousands to one, so that the conclusion Mark Twain arrives at is, that if a man wishes to live a long life he should forthwith obtain a railway pass, and spend his time exclusively in railway travelling, carefully avoiding that most dangerous and pernicious of all places, viz., bed. This idea of Mark Twain's will probably show you the fallacy of attributing deaths during anæsthesia to the anæsthetic alone. In very many cases patients die of an operation during the anæsthetic just as they die in bed of a disease. They are not killed by the anæsthetic any more than the patient is killed by his bed.

The most extensive of all researches on the mode of action of chloroform and its relation to the action of, and probable effects of, shock in healthy animals or in diseased, was carried out at Hyderabad, by the great generosity of the Nizam, at the suggestion of Surgeon Lieutenant-Colonel Laurie, and the results of this commission, of which I was a member, left no doubts in my mind that, as far as the anæsthetic is concerned, in 99,999 cases out of 100,000 it causes the respiration to fail before it affects the heart, and if you attend to the respiration carefully, I do not believe you run very much risk from the heart. But remember that I make this statement only in regard to the anæsthetic, for shock may have a different effect.

Respiration to be watched.—There is no doubt whatever that chloroform is a protoplasmic poison. It will kill any living thing. If you inject it into the femoral artery, you will render the leg as hard as a piece of board; if you dip the heart of a mammal or of a frog into pure chloroform, it also will become hard and rigid. But the question is not what chloroform *can do*; it is the question of what chloroform *does* which concerns us; and those who consider that the respiration is the function that is to be attended to, believe that although chloroform is capable of paralysing the heart, yet it does not paralyse the heart so soon as the respiration when it is taken into the lungs by ordinary inhalation. If you drive chloroform vapour into the lungs by artificial respiration, you can paralyse the heart to a certainty, but ordinarily the heart is not paralysed, for the simple reason that the respiration fails before the heart, and so the inhalation of chloroform vapour is stopped before enough has been taken in to paralyse the heart. So that the rule I should insist upon very strongly is that the respiration be carefully attended to, and if you can only do one thing, and the choice lies between attending to the respiration and attending to the heart, you had very much better attend to the respiration than to the heart, because the respiration is generally affected before the heart. I do not know that there can be any objection raised to the plan of attending to both, which is employed by many administrators of chloroform. They feel the pulse, not where one usually feels it at, viz., the wrist, but in the temporal artery of the patient. While steadying the head with their hand, they keep one finger on this artery as they are giving chloroform, and thus, while they are consciously attending to the respiration, they are at the same time unconsciously feeling the pulse with one finger. So long as the pulse goes on steadily, their attention is not attracted to it, and it does not prevent them from watching the respiration, but if anything goes wrong with the pulse, at once the finger informs them that some accident is occurring, and double attention is immediately excited.

Patient requires undivided Attention if anæsthetised.—But there is one thing that the administrator of chloroform ought not to do, and that is, he ought not to watch the operation. I believe the secret of success in the administration of chloroform is that the administrator shall be able to concentrate his attention upon what he is doing, and not think of the operation nor of anything else. In the work that we did at Hyderabad, it was very extraordinary how few accidents we had in the morning, when people were all attentive to their work. In the afternoon, when they had been to the hospital, and their attention had been distracted, and when possibly the operations were done with more hurry, we were liable to get accidents, but nevertheless very few occurred when one particular man was giving the chloroform. He was accustomed to attend specially to his work, and he was not distracted by attending to anything else except once, when, although present in body, he was absent in mind. We were doing a new operation which he had never seen before, and, instead of attending to the chloroform, he began to attend to the operation, and then we had an accident. The secret of the successful administration of chloroform is just the same as in everything else, viz., careful and exclusive attention to what the man is doing at the time.

Artificial Respiration.—Now accidents may occur, and you have to be on your guard against them. Sometimes the respiration may fail, the pulse may apparently cease, and what are you to do? The first thing is to bring round the breathing by means of artificial respiration. This is done in two ways, as you know. If the respiration be stopped in expiration, as it sometimes is, you must expand the chest, and this you do by drawing the arms up above the head, bringing them down again, and crossing them over the chest, giving a little pressure. This you do at regular intervals, timing the intervals by your own respiration. If the chest is in a position of deep inspiration, it is unnecessary to raise the arms; all you require to do is to press on the chest quickly and relax your pressure. The chest is again filled by the inspiratory spasm, but, as a rule, you find that it tends to stand still in expiration, and therefore the mode of artificial respiration by means of raising the arms, usually known as Sylvester's, is the one required. But the heart is often very feeble indeed and requires to be stimulated. You stimulate the heart not only by pressing the arms down upon the chest, but by getting your own fingers, if possible, just under the ribs of the patient, and as you press down the ribs you push your fingers under them, and thus apply a mechanical stimulation to the heart. In this way you not only accomplish artificial respiration, but increase the action of the heart. At the same time, however, you wish to bring about a more natural condition of the great nervous centres in the medulla, which regulate the respiratory and circulatory systems. When the heart is very feeble, the circulation of blood through those centres is slow and small, and in order to accelerate the flow of blood through them a common plan is to invert the patient. Supposing the patient to be lying upon a table, you tilt up the end of it nearest his feet so that the blood shall flow downwards from the heart to the medulla, and in this way you accelerate the circulation through it and bring your patient round. In the case of children, some men have used the plan of throwing the child over the shoulder, with its head hanging down the surgeon's back, and then trotting round the room with it. The concussion of the child's chest against the surgeon's shoulder acts as a kind of artificial respiration as well as a stimulus to the heart; and, as the head is hanging down, the blood tends to flow to the brain. At the same time it may be advantageous to inject under the skin some ether or strychnine. The ether, which causes considerable pain when the patient is awake, acts here as a local stimulant by irritating the sensory nerves of the spot where it is injected rather than as a general stimulant; for if it were absorbed, its action on the nerve centres would rather tend to increase that of the chloroform. Strychnine has quite a different action: it tends to stimulate the nerve centres in the medulla and in the heart itself, and thus to increase both the circulation and the respiration.

Special Apparatus for administering Chloroform.—I now wish to show you one or two other methods of using chloroform that are frequently employed. The first is one that is very useful, and is known as Junker's method. It simply consists in driving air laden with chloroform vapour into a mouthpiece, from which it is inhaled. If you fancy an ordinary wash-bottle, such as you use in the chemical laboratory, with some chloroform in it and a Richardson's spray apparatus attached to the exit tube of the wash-bottle, you will have the whole of Junker's apparatus. By means of a spray producer, such as is used in Richardson's apparatus, you drive air through the chloroform, and then on through another tube which is attached to a mouthpiece. In Junker's apparatus, we have a wash-bottle greatly diminished in size for convenience' sake, but the principle of it is precisely what I have shown in a diagram. By regulating the rapidity with which you drive the air through the chloroform you are able to regulate the amount of chloroform that passes into the mouthpiece in a given time, and it is quite easy, by simply regulating the amount of chloroform vapour and by putting the mouthpiece more or less tightly before the face, to adjust the amount of chloroform that the patient takes. This apparatus is a good deal used for the induction of anæsthesia during operations, but it is also very useful for the relief of pain when other things fail to give ease, for example in cases of intense neuralgia or in the extreme agony which patients experience during the passage of a gall-stone or of a renal calculus. There is a small funnel in the top of the bottle, through which the chloroform is poured. By means of a hook, it is hung from the button-hole of the administrator, who places the mouthpiece over the patient's face, and by gently working the india-rubber ball drives the air through the chloroform. Chloroform vapour thus reaches the patient's face, and by working the ball more quickly or more slowly and by holding the mask more or less tightly over the face the amount of chloroform a patient takes can be regulated with great nicety.

There is another advantage which this apparatus possesses, and that is, it may be used for self-inhalation. As a rule, it is a most risky thing for men to get into the way of inhaling chloroform for themselves, but sometimes it may be absolutely necessary for you to relieve your patient by telling him how to inhale chloroform himself.

Self-inhalation of Chloroform.—Let us suppose, for example, that you are in country practice. You have one patient suffering intense agony from a biliary calculus. While you are in attendance, a messenger comes and tells you that another of your patients is in labour, and that you must go there at once. What are you to do? If you leave the one patient you allow the pain to continue, and if you do not go to the other patient some mishap may occur. In such a case as this, the best plan is to let your patient relieve himself by the self-administration of chloroform, while you go and attend to your other work. If, for example, you have got one of Junker's inhalers, you hook it up to the top of the bed, tell the patient to put the mouthpiece before his face and go on slowly pumping and inhaling the chloroform vapour. When the chloroform begins to take effect of course the action of the hand gets less and less vigorous, until at last, when he becomes completely anæsthetised, it stops altogether. We have thus a sort of self-regulating apparatus, for the more the pain keeps the patient awake and stimulates him the more vigorously does he pump the chloroform on to his face. As the chloroform begins to take effect the action of his hand becomes feebler and feebler, less and less chloroform is inhaled, and finally he stops altogether, again recommencing when he comes out of the anæsthetic, and the pain begins to trouble him.

One precaution in using this apparatus is to see that the tubes are properly adjusted. In the diagram, the indiarubber ball is fastened to the long tube which goes down into the chloroform, and the inhaler is attached to the short tube that comes up from the top of the bottle; but supposing this were reversed, what happens? You blow vigorously, you drive a stream of pure chloroform straight on to the patient's face and up his nose, and you very nearly choke him. This is a sort of accident that you would not think of, perhaps, and I do not think I should have thought of it if I had not seen it occur; but the symptoms it produced were so severe that I think it is worth while to impress upon you that you should always remember, in using the apparatus, to be very careful to avoid such an accident.

Substitute for Junker's Inhaler.—Now, you may be in the circumstances that I have just supposed without having a Junker's apparatus at hand, and what is to be done then? The best plan is to get a tumbler and a bit of blotting-paper, to fold the blotting-paper up, and sprinkle a few drops of chloroform upon it. You then tell the patient to hold the tumbler to his nose and inhale gently. As soon as the chloroform begins to take effect the hand falls down, he ceases to inhale, and directly the effect passes off the hand goes up, and he inhales again. This method may be used not only to relieve the pain of neuralgia, of gallstone, or of renal calculus, but also to alleviate the pains of labour, because patients can do themselves little or no harm with it, provided always you take the precaution that the bottle of chloroform is not entrusted to the patient. The reason for not letting the patient have the chloroform bottle is that when she is half over she may, while pouring a little chloroform into the tumbler, allow the stopper to fall out, and the chloroform to flow out on to the bedclothes or the pillow. In this way you may get the bedclothes drenched with chloroform, the half-conscious patient becomes more and more deeply anæsthetised, and after awhile she is chloroformed to death. This is an accident that has already occurred too many times, and, therefore, you must be very careful that the patient never gets the bottle into his or her care, but that all the chloroform is soaked up in the piece of blotting-paper in the tumbler.

There is another little precaution that I should have hardly thought of mentioning, which is that before the tumbler is entrusted to the patient you should turn it upside down. I was once giving chloroform to a patient in this way, and there was a trained hospital nurse in attendance. She was just going to hand the tumbler to the patient, when I noticed that there was a lot of fluid in it, and I found that the tumbler was one-third full of pure chloroform. Instead of putting a few drops, as I had told her, just enough to saturate the paper, the nurse had poured in enough chloroform to fill the tumbler one-third. Of course the patient in such a case ran a great risk of being chloroformed to death. This same method of using a tumbler may be employed also as an adjunct in cases of sleeplessness. There are some people who cannot get to sleep, and, even although you use strong narcotics, they remain awake for a length of time. Occasionally by giving a little chloroform in a tumbler to such people you put them partially over, and the narcotic begins to take effect, so that the chloroform and the narcotic together give you a result which cannot be obtained from either singly. I should also mention that in some cases, where it seems advisable not to give chloroform for too long a time, morphine may be used in order to prolong the action of chloroform.

I mentioned to you that the only case I had ever seen of death upon the operating table was one of excision of the supra-maxillary bone. In this instance the patient was only able to take a small amount of chloroform, and the remainder of the operation was conducted without anæsthetics. In another case, in which Dr. Crombie, an old fellow-student of mine, operated, he succeeded admirably in keeping the patient under the whole time by giving him a subcutaneous injection of morphine before he began the operation. The operation was commenced under the influence of the chloroform, but before the bone was cut the effect of the chloroform, the administration of which had been discontinued, had probably passed off, yet the patient remained unconscious under the influence of the morphine. Thus you see that a combination of morphine with chloroform in such cases may sometimes be exceedingly useful.

Effect of one Sensation upon another—Inhibition.—We must now pass on from the anæsthesia produced by drugs to another method which was sometimes used before the introduction of anæsthetics. Before the introduction of ether or chloroform several operations were performed without any apparent pain to the patient. You will also find recorded in Foxe's "Book of Martyrs" some very curious statements regarding the condition of people who were tortured by the Inquisition. It is said that some of them not only felt no pain, but felt positive pleasure, so that they regretted being removed from the rack, which seemed to them a bed of roses. Now the reason of this appears to be that one is able in some cases to throw the cerebral hemispheres out of gear—to interfere with the action which they usually exert. There is an action which is termed inhibition, exerted by one part of the brain over another. In the frog this power seems to be located chiefly in the optic lobes (Fig. 77). You know that if you stimulate a sensory nerve

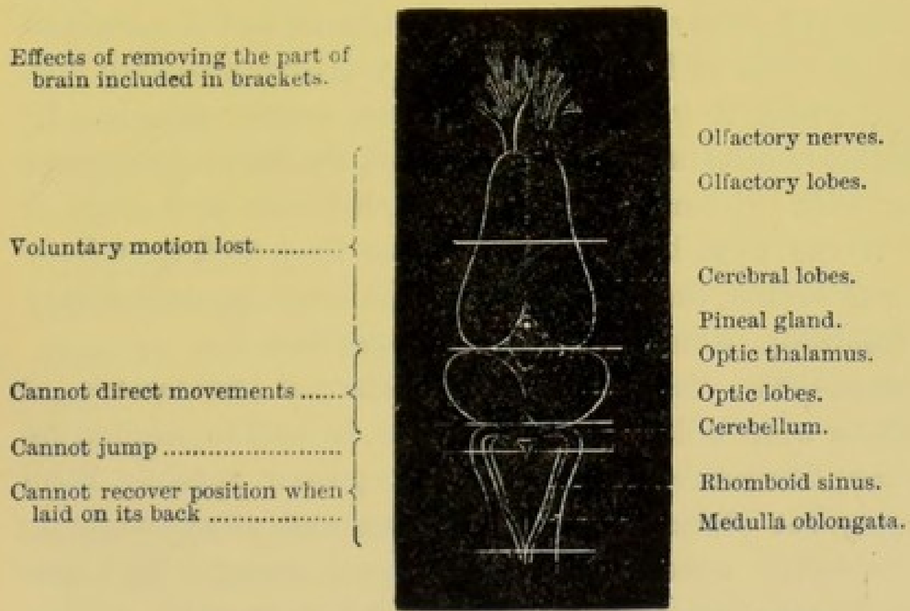


FIG. 77.—Diagram of the higher nerve centres of the frog.

in the frog, in the foot for instance, you usually get a reflex twitching of the leg, but if you stimulate the optic lobes at the same time you get no such twitching. The optic lobes have exercised what is termed an inhibitory action upon the spinal cord, stopping the usual reflex which would be exerted through the cord. If, in place of stimulating the optic lobes, you stimulate the optic nerves, you apparently get a very similar action, and what we find in the frog we also find in man. Supposing, for example, that you go some night into a dark room—you put your hand upon something or another in the dark, and find it cold, wet, and clammy. You give a sudden start; that is, the sensory stimulus from your hand has passed to your spinal cord, and probably your corpora quadrigemina, and through them has produced reflex action of your muscles, resulting in a jump. Perhaps you feel at the same time an uncomfortable sensation down your back. But supposing somebody else comes in with a candle at that moment, and you see that the cold, wet, clammy, and disagreeable thing you felt is only a bit of soap, you would not jump at all. The reflex action which the contact of the wet soap with your skin produces in the dark is stopped in the light through your optic nerves; through them inhibition of the sudden reflex start which was produced in the dark has occurred. Just as the optic lobes have the power of inhibiting, so they have the power of starting movements, and if a sudden movement be made in front of your eye you give a sudden jerk backwards, which if you were blind you would not do. In man a double action seems to be exerted by the nerve centres connected with vision, viz., that of inhibition and that of motion. If the eyes be wearied, so that they no longer have their normal action, the other parts of the brain get into a very peculiar condition, which is known as hypnotism.

Hypnotism.—The monks of the celebrated monastery of Mount Athos were able, as they thought, to get to heaven by the very peculiar process of contemplating their navels. Each monk simply sat staring at his umbilicus, and after awhile he became perfectly unconscious of external objects and was transported, as he thought, to heaven. Now a method similar to that followed by them is employed by the modern hypnotists: that is to say, they generally make the patient stare steadily at something bright a little in front of, and a little above his eyes, until they become wearied; then the patient becomes unconscious of external objects, and he acts upon suggestions made to him from without. I do not know whether you saw some time ago a demonstration of hypnotism by a former student of this Hospital, in which he made a man act simply as a puppet. There could be no doubt about the *bona fides* both of the operator and of the man operated upon. The subject was told, for example, that a chair was placed for him, and he would try to sit down upon it when there was absolutely nothing there, and he would try to walk straight through a table which really was there, but which he did not see, having been told it was not there. He simply saw and did the things that were suggested to him, and appeared quite unconscious of the impressions which his senses would have furnished to him in his healthy state.

For a long time the idea of suggestion was scouted, but there is no doubt whatever about the truth of it, because we can produce similar effects not only in man, but in the lower animals. Most of you know that one of the oldest experiments described in handbooks of parlour magic is to hypnotise a fowl. You get a fowl and put it on the floor or on a table, with its beak upon the board, and draw a chalk line out from the point of the beak straight out for about 3 feet. The fowl which was previously obstreperous becomes, as a rule, perfectly quiet. When it is thoroughly under you can generally raise it by its legs, and it remains perfectly quiet, with the wings down and hanging flaccid. I show you here a fowl which is excited, noisy, and obstreperous. By holding the wings very gently, but very steadily, close to its body, gently pressing the head down so that the beak rests against the table, and drawing a chalk line from it, the fowl at once ceases its noisy struggles, and behaves almost as if it were dead. One difficulty is to keep the head quite quiet upon the line, for when the beak moves away from the line the fowl begins to get restless. It is usually awaked by blowing upon it. You will observe that the effect upon the eyes is not the only factor in the production of the hypnotic state. A great deal can be done by simple quiet, steady pressure, and fowls, rabbits, frogs, and even lobsters or crocodiles may be hypnotised by pressure alone. In the case of frogs, the hypnotism is produced and maintained almost entirely by pressure. When the frog is placed upon the board it tries to get away, but after awhile, when the steady pressure has shown it that it cannot move, and the hands are taken away *very, very gently*, the frog continues to sit still, will sometimes remain quiet until it is dried up to a mummy without ever making any voluntary

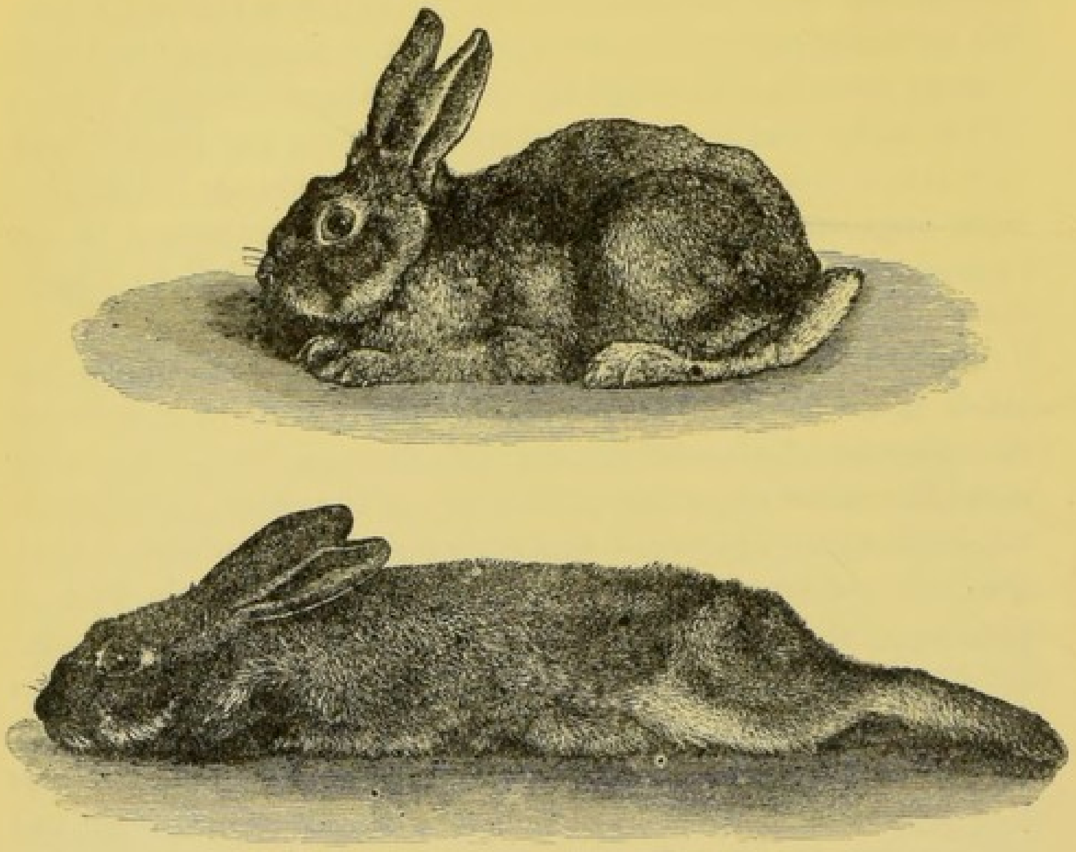


FIG. 78.—Rabbit in normal and hypnotised states.

effort. In the hypnotic condition suggestions appear to be more easily received, and to have an effect which is both greater and more prolonged than they would in the ordinary waking condition. But even in ordinary waking conditions suggestion is by no means void of effect. You may have heard of the man upon whom his friends wanted to play a practical joke. One of them met him in the morning and said, "You are looking very ill;" a second met him and said, "How miserable you are looking;" a third said, "How awfully ill you are looking;" and a fourth one said, "How dreadfully ill you are looking. You ought to be in bed." The man was so convinced that he was ill by the reiteration of his friends that he went home, went to bed, and became very ill. So that suggestion in the waking condition has a good deal to do with the feelings of a patient. Moreover, we know that suggestion will tell also upon the functions of the digestive tract, and that a bread pill which has been given to a patient with the assurance that it would prove a powerful purgative has actually been so, and has produced a brisk action.

I believe that a good deal of the influence which certain medical men have upon their patients is due to their power of suggestion. You sometimes meet with men who may be really ignorant, but are nevertheless most thoroughly convinced of their own knowledge and of their own superiority; you may find that these men are not only more acceptable practitioners, but are perhaps even more successful in their treatment than other men who are very much better up in their profession. Their patients believe in them, take the medicine they prescribe, whatever it may be, and the result they have expected follows.

In the condition of hypnotism, suggestion seems, as I have already said, to be both more powerful and more persistent than in the waking state. When the patient has been put into the hypnotic condition, the mere suggestion that illnesses which are actually present will disappear is followed by the result which is expected and wished.

This process of healing by suggestion has been chiefly worked out at Nancy by Liébault, who was the first to introduce it. I went to see his clinique at Nancy some years ago. He had a number of patients ranged around his room. One of them was suffering from irritability of the bladder; he was put into the hypnotic state. Some of those who had been treated before were thrown into this state by a few passes made before their faces; others who had been hypnotised before, and were more susceptible, were simply told to sleep, and they went to sleep at once, because the repetition of the hypnotic condition allows the operator to bring it on more readily than before. When the patient with the irritable bladder had been put to sleep, Liébault simply said to him, "When you awake you will have no more pain; you will have no more desire to pass water." Then he stopped. "When you awake you will have no more desire to pass water; you will have no more pain." He reiterated this again and again in a somewhat monotonous voice, and then with a sudden flick of a towel before the patient's face he woke him up. The suggestion made during the hypnotic state seemed to continue during the waking condition, so that there was less pain and less desire to pass water in this case. Other patients were treated in the same way. For example, in a case of bronchitis he said, "When you awake you will have no more cough, no more spit, no more pain in your chest," and again, "You will have no more pain, no more spit, and no more cough;" and when the patient woke he had less pain, less spit, and less cough. Occasionally in cases of acute pneumonia, instead of giving a narcotic, Bernheim and others of the Nancy school simply said to the patient, "Sleep," and he slept.

Faith-cure.—Faith-cure may perhaps be regarded as a special form of treatment by suggestion. The faith-cure is a very old one indeed, and you will find in the Epistle of James the direction: "Is any sick among you? Let him call for the elders of the church, and let them pray over him, anointing him with oil in the name of the Lord. And the prayer of faith shall save the sick, and the Lord shall raise him up." We find the same sort of treatment followed at the present day in the Holy Wells. Patients go there, they hang up a bit of rag, and they get well. At Lourdes you see the same result. All round the grotto at Lourdes hang multitudes of crutches and sticks that have been thrown away by patients who went there lame and came away well. A very instructive case was related to me by a friend of mine, an old Bartholomew's man, whose cousin had had an injury to her leg. She was treated by various surgeons in London, and the injury was practically healed, but the patient would not believe that she could walk. She went to Lourdes, and after a couple of days there she threw away her crutches and was quite well, although while in London she was convinced that she could not walk. The doctors here were convinced that she could, but she would not. Most of the cases of cure are cases where the idea has prevented the patient from walking, but where there has not been organic disease. One can hardly expect organic disease to be cured at such places as Lourdes, but the belief is efficacious in purely supposititious diseases.

Melancthon.—Yet even in cases of very serious or dangerous illness patients have been brought round apparently from the gates of death by the effect of faith or of strong emotion. It is said that the celebrated Scottish Reformer, John Knox, was once apparently dying, when some Roman Catholics, of whom he had a great hatred, came round his bed and wished to administer extreme unction. This so irritated the reformer that he jumped up in bed and said: "I won't die, but I will get well and plague you yet." He kept his word. The story is also told of Melancthon, Luther's great friend, that he was seriously ill and at the point of death, so that Luther was sent for to see him before he died. On Luther's arrival he at once said: "You must not die, Philip; we cannot spare you." "Oh! let me die quietly," said poor Melancthon. "No, Philip, you must not die." Then falling on his knees, Luther offered up a most vigorous prayer that Melancthon should live and should be spared for the present. At its conclusion he jumped up, and said to his friend: "Now, Philip, you cannot die," and Luther's strong belief so affected his friend that Melancthon, instead of dying, set about getting well as quickly as possible.

Homœopathy.—Another plan of treatment, which may be regarded as in great measure one by suggestion, is homœopathy, which is exceedingly good, especially for supposititious diseases. Homœopathy is practically, in many instances, a method of faith-cure. But it is not always so, for some of the homœopathic drugs are excessively powerful. Some of these preparations, and more especially those of aconite, are not things to be tampered with; but some of their drugs, such as *Carbo vegetabilis,* which is simply vegetable charcoal, so much attenuated by admixture with sugar of milk that there is practically no charcoal in it, can have no action except through the imagination.

Mattei System.—Another variation of the faith-cure is known as the Mattei system, and some of your patients may very likely ask you about this. Count Mattei is supposed to cure cancer and a whole lot of other things, and I was anxious to learn something about the system. I had a good opportunity of seeing it once at Lucerne. A lady had, unfortunately, a very bad toothache. I tried cocaine, morphine, and various other things which I had by me, but I could not relieve the pain, which was excessive. The landlady of the hotel said: "I have got here a woman who knows the Mattei treatment; she will cure it." I said: "If she can cure it, by all means let her do so." The woman came accordingly, bringing with her a box in which were some vials containing some little white globules. One vial was labelled "Blue electricity," another "Green electricity," and another "Yellow electricity." She took two tumblers, filled one of them with water, and dissolved a globule of blue or yellow electricity in it. She then put a teaspoonful of the solution into the second tumbler, filling it up with water, and dipping her finger into the mixture, rubbed it on the patient's cheek. After a minute or two she said very emphatically: "Now you are better." "No," said the patient; "I am not better." "But you *must* be better," and she rubbed on some more. This went on again and again, but still the patient got no relief. But the woman's absolute conviction and her continued insistence that the pain must be better would, I am quite sure, have made any patient believe that he was better, if there had been any room for imagination, but severe toothache does not allow of much play to this faculty.

Antispasmodics.—We may now pass on to the effect of antispasmodics. Antispasmodics are drugs that tend to lessen spasm. Sometimes you may lessen spasm by lessening irritation; at other times you may do so by increasing the inhibitory power of the higher centres over the lower. We may have local spasm and general spasm. Local spasm is frequently found in organs consisting of involuntary muscular fibre, for example in the arteries, in the stomach, in the intestine, in the ureter, and in the bladder. Spasm of involuntary muscular fibre may very often be relieved by means of warmth, and spasm in one part of an organ consisting of involuntary muscular fibres is frequently associated with dilatation in another part of the same organ. For example, in the colon, instead of the intestinal wall being equally contracted or dilated throughout, you may find that it is contracted in one part, while it is dilated in another, and the same thing occurs in the arteries of the head in migraine. By the application of warmth we seem to equalise the contraction in the different parts either of the colon, or of other organs consisting of involuntary muscular fibre, and thus we relieve the spasm and the accompanying pain. Belladonna is one of the most useful drugs for relieving spasm of this sort that I know of. Opium is frequently employed, so are the bromides and many of the newer analgesics, such as antipyrin, phenacetin, antifebrin, and salicylate of soda. A mixture of bromide of potassium and salicylate of soda is very efficacious in relieving the spasm of the vessels which accompanies migraine.

General spasm may be relieved by means of such drugs as alcohol, ether, or chloroform, and in many cases also we may relieve it by sedatives, such as bromide of potassium. In the spasm which is connected with epilepsy, bromide of potassium is one of the most useful remedies we possess; in chorea, where spasmodic twitchings are present, arsenic has been recommended, but I do not think it is of very great use. I have never seen the good results from arsenic that have been lauded by others. In hysteria, where we have a general spasm, we find that not unfrequently the spasm may be relieved by means which tend to raise the blood pressure. For example, stimulation of the nasal branches of the 5th nerve by strong irritants, such as ammonia, carbonate of ammonia, or strong acetic acid, which is often employed under the name of aromatic vinegar, often does good, and stimulation of the stomach by means of carbonic acid or ammonia or aromatic spirit of ammonia, or by brandy, does so likewise. But one requires to be very cautious in cases of this sort to avoid the employment of stimulants, lest the patient should acquire the habit of using them. One always prefers the aromatic spirit of ammonia to brandy or wine, because the habit of drinking sal-volatile is much less likely to be acquired than the habit of drinking brandy, on account of the ammonia having a strong irritant action upon the stomach, which tends to produce gastric catarrh and nausea much sooner than brandy. Then there are certain other drugs used as general antispasmodics: castor, valerian, and musk. Valerian is a very powerful one, and it is very frequently used in the case of hysteria. We have in the Hospital Pharmacopœia a draught which is used for this purpose.

Drugs acting on Organs of Special Sense.—*Eye.*—We now come to the action of drugs upon organs of special sense. In the case of the eye we have various substances that tend to lessen irritation of the conjunctiva. One of the commonest of these is the so-called Goulard water, or Liquor Plumbi Subacetatis Dilutus. This is used as a wash, and it has a very soothing action; but there is one point that has always to be remembered, and that is that if the patient have an ulcer on the cornea, the lead may settle upon that part, and by combining with the protoplasm in the ulcer may lead to a permanent opacity, so that, as a rule, you only use the Goulard water when there is no ulcer or abrasion upon the cornea. Belladonna and opium are both frequently employed to lessen irritation in the conjunctiva. We have in the Hospital Pharmacopœia a number of washes, all of which are very useful in lessening irritation in the eye. A mere enumeration of them will almost show you for what they are employed. First you have one of boric acid with opium, in which the boric acid acts as an antiseptic and antiphlogistic, and tends to lessen conjunctivitis, while the opium acts as a sedative, lessening irritation and pain. Next we have another one, consisting of atropine and sulphate of zinc, in which the sulphate of zinc acts as an astringent, and the atropine tends to relieve pain. We have also a lotion of opium only for the purpose of relieving pain and irritation, without any astringent action.

LECTURE 13.

Action of drugs on the conjunctiva, *continued*—Action of drugs on the pupil—Mydriatis—Myotics—Action on accommodation—Vision and visions — Hearing — Smell — Taste — Respiration — Sternutatories—Cough.

Gentlemen,

We were discussing in the last lecture the action of drugs upon the conjunctiva, and I mentioned to you that there were several drugs which were used for the purpose of lessening conjunctiva inflammation. One of the commonest of these is lead, and the objection to lead salts is that, if there be any ulceration upon the cornea, the lead may become deposited upon the surface of the ulcer, forming a permanent opacity. On this account, lead has been, to a great extent, neglected of late years, and preference is given either to salts of zinc, salts of mercury, or boric acid. Perhaps boric acid is more used than almost any other substance for the purpose of lessening conjunctivitis. Along with boric acid we may use certain sedatives to relieve the pain and irritation which may be present. Amongst them we have especially belladonna and opium, both being useful applications.

Action of Drugs on the Pupil.—We may now consider the action of drugs upon the pupil. The pupil, as you know, consists of involuntary muscular fibre, or, as is usually assumed, of two sets of involuntary muscular fibres: a radial set, which dilates the pupil, and a circular set, which contracts the pupil. The radial one has not been certainly demonstrated, but its existence is always assumed. For my own part, I am inclined to think that the whole of the phenomena of dilatation and contraction of the pupil may be better explained on the assumption that muscular fibre may contract in both directions; that, instead of a spindle-shaped muscular fibre contracting only in the direction of its length, it may possibly have the power of contracting in the direction of its breadth. For example, I show you a drawing of an involuntary muscular fibre (Fig. 79). We know that it can contract in the direction of

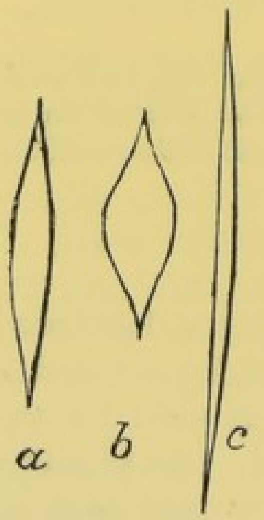


FIG. 79.—Diagram to illustrate hypothesis regarding the contraction of muscular fibre, voluntary or involuntary. *a* is a normal muscle; *b* is the same contracted in the direction of its length and consequently increased in thickness; *c* is supposed to be the same contracted in the direction of its thickness and increased in that of length.

its length, shorten, and become thicker, but it seems to me quite possible that, instead of the two ends approximating, the two sides might do so, and thus we should get a forcible elongation instead of a forcible contraction. This view, however, is not generally accepted, and it is usually believed that there are two muscles in the iris sets: the dilator and the sphincter. These muscles are usually excited to action by nerve centres. The nerve centre for the sphincter iridis is situated in or about the floor of the third ventricle; it may, however, be partly situated in the medulla oblongata. It is probably a somewhat elongated centre. The difficulty of localising these centres exactly arises partially from their smallness, so that it is difficult to locate precisely any stimulus applied experimentally to them, and also from the fact that there are generally more centres than one. The stimulus from the nerve centre passes through the third nerve on to the sphincter of the iris, and causes the pupil to become smaller.

There seem to be two centres also for the dilator, one of which is situated in the medulla oblongata, and another about the third ventricle (Fig. 80). The dilating fibres pass down

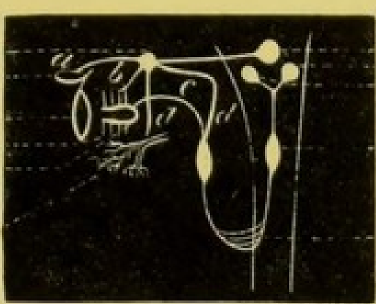


FIG. 80.—Diagram to show the nervous supply of the eye. *a*, nerves to the ciliary muscle regulating accommodation; *b*, nerves to the contracting fibres, and *c*, nerves to the dilating fibres of the iris; *d*, vasomotor nerves to the vessels of the eye. The iris is put apparently behind instead of in front of the lens for convenience in showing the passage of nerves to it.

the cervical cord and through the sympathetic on to the iris. Both of those centres may be affected by various conditions, and more especially by asphyxial blood, which stimulates them, so that the pupil dilates. Ordinarily both the dilator and the sphincter muscle are kept in action by reflex stimuli, and when the sensory tracts through which they are excited are paralysed either by disease or by the action of drugs, both the movements of the pupil and its size undergo alterations. The sphincter centre is more affected by stimuli from the eye itself; the dilator responds more to stimuli from the body generally, whether painful or otherwise. Thus, in cases of disease of the spinal cord associated with degeneration of the sensory tracts, we find a want of reaction of the pupil to light, although it still contracts on accommodation. We find great contraction of the pupil in some such cases as well as in hæmorrhage into the pons varolii, and in poisoning by opium or physostigma. In the first stage of anæsthesia, when the effect of reflex stimuli becomes diminished, the pupil tends to contract, and a similar contraction occurs under the influence of opium. But if, during the administration of anæsthetics, the circulation suddenly fails, you then get stimulation of the dilating fibres, and consequently a sudden dilatation of the pupil, which is always a sign of great gravity during the administration of an anæsthetic. If you happen to find that the patient's pupil has suddenly dilated, you must look at once with great attention to the condition both of the respiration and of the heart.

Mydriatics and Myotics.—We have certain drugs, however, which act more powerfully even than anæsthetics upon the eye. These are divided into two classes: the mydriatics, which dilate, and the myotics, which contract the pupil. The chief mydriatics are atropine and other alkaloids nearly allied to it; the chief myotic is physostigmine, which causes marked contraction of the pupil. Now, both of those drugs have the power of acting locally upon the iris, because they will act upon the iris of an eye after it has been freshly excised, and thus removed from all influence either ot the circulation or of the central nervous system upon it. There is another drug which has the power of causing dilatation, viz., cocaine. It does not, however, cause dilatation in the same way as atropine. Atropine causes dilatation chiefly, though not entirely, by paralysing the ends of the 3rd nerve in the iris, although it seems also to have a certain stimulant action upon the dilator fibres. Cocaine produces dilatation by stimulating the sympathetic nerves. Atropine and physostigmine are, to a considerable extent, antagonistic to one another, and the effects of one drug may be removed by the subsequent application of the other.

There is another point on which I should have laid more stress when speaking of the effect of morphine on the contraction of the pupil. I ought to have impressed upon you that morphine appears to contract the pupil almost to a pin's point in cases of poisoning by it. You are very likely to be called upon to decide whether the condition of a patient is due to disease, to poisoning, or to drunkenness, because many of you will become house physicians or house surgeons. Some time in the early morning, when you are on duty, a patient will be brought by the police into the surgery. You examine him, and find that his breath has a strong smell of whisky or brandy. This is presumptive evidence of intoxication, but it is not conclusive, for he may have been found unconscious, and spirits may have been given in the attempt to revive him. If his pupils are dilated, intoxication is probable. But you may find that he has pin-point pupils. Now this is a condition which may be dependent upon the administration either by others or by the patient himself of opium or morphine, but it may be also dependent upon hæmorrhage into the pons varolii. Sometimes you can distinguish between the two conditions by the pupils. In the case of opium poisoning they are alike, and in cases of hæmorrhage into the pons you may find one somewhat larger than the other, but this is not a rule of universal application. In intoxication, either by alcohol or opium, the arms are alike, but in pontine hæmorrhage one arm when lifted is likely to be more rigid or more flaccid than the other. But it is well to err always on the safe side, and whenever you get a case of unconsciousness with pin-point pupils, be very careful in your treatment of it. Do not send the patient away in the care of the police and say he is dead drunk, but if there is the least doubt about his condition, take him in at once and pay the utmost attention to him, because it is from the difficulty of diagnosis, and sometimes, perhaps, from the want of sufficient care, that cases of scandal arise where patients are sent away from hospitals as being drunk and incapable, and afterwards die in police cells.

Action on Accommodation.—In addition to the effect of mydriatics and myotics upon the pupil, they have the power of acting upon accommodation, and atropine not only paralyses the iris and causes dilatation of the pupil, but also paralyses the ends of the nerve going to the ciliary muscle, and thus it produces paralysis of accommodation. Physostigmine, on the other hand, which causes spasmodic contraction of the iris, causes likewise contraction of the ciliary muscle with a spasm of accommodation.

Uses.—We use atropine for various purposes, the most common application of all being to dilate the pupil for the purpose of examining the eye with the ophthalmoscope; the next, perhaps, is to paralyse the ciliary muscle, and thus determine the refractive power of the media. It is used also for the purpose of seeing whether there is any peripheral cataract commencing. By dilating the pupil you are able to see the edge of the lens, which you could not see with a contracted pupil. Atropine may be used also to enable a patient to see round a central opacity in the lens. With a contracted pupil and a central opacity, the patient's vision is completely destroyed, but if you dilate the pupil the patient may be able to see round an opacity in the centre. Another reason for using atropine is to prevent prolapse of the iris after cases of operation. By getting the pupil completely dilated you are able to prevent the iris from prolapse. Supposing that there is a wound in the cornea, and the iris is not dilated, its edge might prolapse, but if it is drawn tightly up, there is no chance of prolapse. Another reason is to break down adhesions. Supposing, for example, that the iris has become adherent, you may manage to break down the adhesion by dilating the pupil, and especially by causing alternate dilatation and contraction by applying atropine and physostigmine successively. A further reason for employing atropine is that it sometimes tends to relieve headaches. Spasmodic contraction of the ciliary muscle is frequently associated with headache, and the application of atropine, by paralysing accommodation, tends to relieve the headache. But there is one point in the use of atropine that you must bear in mind in relation to headache. In certain conditions of the eye, the tension is very greatly increased, and this condition of increased tension in glaucoma is often accompanied by intense headache. But in such a case as this the application of atropine would make matters worse instead of better, because it would increase the tension in the normal eye. The fluid in the anterior chamber passes through small channels close to the attachment of the iris into small lymphatic channels, through which it is conveyed away (Fig. 81). If atropine be used, and the iris be drawn close up to the cornea and thus thickened, these channels become more or less obliterated. Thus, in a person who is just about to suffer from glaucoma, a fit of it may be brought on with intense pain and damage to the eyeball by the use of atropine.

When the pupil has been dilated by means of atropine for the purpose of examination, instead of allowing its effect slowly to pass off, you may counteract it by applying physostigmine. In cases of glaucoma also, physostigmine will tend to cause the pupil to contract and leave the lymph channels free, and thus allow the fluid to escape more readily from the anterior chamber of the eye, and in this way tend to prevent glaucoma.

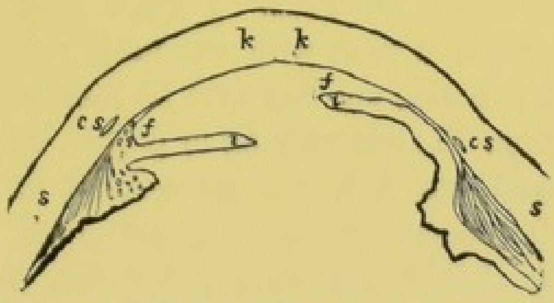


FIG. 81.—This diagram (which I owe to the kindness of Mr. J. Tweedy) represents a section through the corneo-scleral region, ciliary body, and iris of a healthy eye (left side), and of a glaucomatous eye (right side): *k*, cornea; *s*, sclerotica; *i*, iris; *f*, spaces of Fontana; *c s*, canal of Schlemm. In the glaucomatous eye the ciliary body is atrophied, and the iris lies against the cornea, preventing the escape of fluids through the spaces of Fontana and canal of Schlemm.

The easiest way of applying these drugs to the eye is in the form of small lamellæ. These are little discs of gelatine, each containing a certain quantity of the drug. I show you some containing atropine, physostigmine, and cocaine. A small camel's-hair pencil is simply wetted, and it takes up one of the discs, which may be then easily transferred to the eye. They are so small and so thin that you will hardly see them at a distance, so I pass one round, and you will see how exceedingly convenient they are. By putting one into the eye and allowing it to dissolve, you are able to apply the exact dose you require directly to the eye without the least trouble. Cocaine has the further advantage of causing anæsthesia of the eye, so that it may be used in cases of operation without the trouble of putting the patient under the influence of a general anæsthetic, an advantage which I have already discussed when speaking of general anæsthetics.

Power of Vision.—There are certain drugs which affect the sensibility of the eye, and more especially is this the case with strychnine, which seems to render the field of vision larger, the sight more acute, and increases the capacity of vision for blue. Strychnine, therefore, has a great power of increasing the sensibility of the eye. I need not trouble you with its action upon the rods and cones, because it is somewhat difficult to understand without a diagram, and in my "Text-book of Pharmacology" I have described it fully.

Visions.—There is another condition which is of a good deal of importance practically, and that is the visions which are produced by the action of drugs. I was a good deal astounded once, when attending a man who was taking salicylate of soda for rheumatism, to notice one day that he seemed to have got into a state of delirium. He was talking of people who were walking round and round his bed, and he seemed to see visions of troops of people constantly marching round and round him. I thought at first that it was simply delirium due to the high fever, but on taking his temperature I found that it was quite normal. Then it occurred to me that his visions were due not to delirium, but to the action of salicylate of soda, and this turned out to be correct. There are a great many people indeed in whom salicylate of soda will produce visions, very often disagreeable visions, ugly faces, and so on, if they simply shut their eyes after taking the drug. There are not very many to whom visions occur when their eyes are open, but if the drug be pushed to any great extent visions may occur when the eyes are open, and this may prove a source of great terror both to the patient and to his friends. The visions, however, appear to vanish rapidly after the drug has been stopped. I mentioned to you before that some other drugs have a similar power, such, for example, as cannabis indica.

Another very important action of a drug upon the eye is the dimness of vision produced by tobacco. Not unfrequently this is overlooked, but whenever you get patients complaining of dimness of vision, it is well to find out how much tobacco they smoke, and if it is excessive either diminish it or stop it entirely.

Action of Drugs on Hearing.—The sense of hearing is acted upon by various drugs, and salicylate of soda seems to have the power of irritating the cerebral centres for hearing, just as it irritates the centres for sight. Thus, at the same time that the patient is complaining of visions, he may be complaining also of subjective sounds, which usually take the form of humming noises or the ringing of church bells, but sometimes they may take the form of audible voices directing the patient to do certain things. You will find that a similar condition is brought on by quinine, so that one of the first indications that salicylate of soda and quinine are producing their physiological action is that the patient begins to complain of noises in the ears. But at the same time that he hears subjective noises he becomes less conscious of objective sounds; he becomes somewhat deaf at the same time that his ears are singing. Singing in the ears, as a pathological phenomenon, is common in advanced age, and is frequently due to some change in the vessels of the ear. It is very difficult indeed to treat, but hydrobromic acid and bromides sometimes seem to afford a certain amount of relief. In one case at least I have found that the patient was very much comforted by having a small induction coil, which one uses for physiological purposes, put beside the bed. The humming of the coil seemed to interfere with the humming that was going on in the head, and to render the patient much more comfortable. Many of those patients are much more comfortable when they are sitting in a railway carriage; the humming of the train seems to dull the subjective sounds, and thus they do not complain while they are in the railway carriage, although the sounds become again very loud and disagreeable when they leave it.

Action of Drugs on Smell.—The sense of smell may also be affected by drugs. It may be rendered keener by the use of strychnine, and not only so, but it is said that disagreeable scents are felt as agreeable ones; so that in this respect persons under the influence of strychnine resemble, to a certain extent, hysterical people, in whom the sense of smell is often excessively keen, and in whom also there is a liking for smells that to many people are disagreeable, such as the smell of valerian, musk, or castor.

Action of Drugs on Taste.—In regard to the action of drugs upon taste, it is usually said that doctors have a way of prescribing very disagreeable remedies, and this is quite true, because many of the drugs that we use are exceedingly disagreeable. In order to get over the dislike that patients have to our drugs there are various ways of administering them, and within late years the pharmacists have given more attention to the production of agreeable forms of administration than heretofore. One way of getting over the difficulty is to give the drug in a very condensed form by using instead of a tincture, infusion, or decoction, the active principle, which may be made up with sugar of milk into a very small granule or globule, so that it is swallowed without the patient tasting the drug at all. Other drugs, which are more bulky and cannot be swallowed in this way, are taken in cachets. The old-fashioned way of giving disagreeable powders was to put them into jelly or jam, which was a most unfortunate way, because, as a rule, when the child took the jelly or jam into its mouth the vehicle broke, and the inside of the mouth was smeared all over with a disagreeable drug which was contained in the jelly, and so the poor child got more than its fair share of the objectionable taste. Sometimes children cannot swallow a pill even with the help of jelly or jam, but you may get a child to swallow a pill easily by a simple plan, which it is well to note, because you will sometimes have a great deal of difficulty in getting the drugs that you wish taken by a child. You may be perfectly certain that a small child cannot swallow an ordinary 5-grain pill at all, but you can cut the pill up into several small pieces, and the best vehicle to get it down is, I think, oatmeal porridge, because the oatmeal porridge is sufficiently consistent not to give way in the mouth. The best way is to put a little oatmeal porridge in a teaspoon, having the teaspoon half full, make a depression in the centre of it with your finger, put in the little bit of pill that you wish to administer, cover it over with the porridge, and then put a little milk in the back of the teaspoon. The child will take this readily enough, and the pill, being thoroughly enveloped in the porridge, will pass down without being tasted in the least. Another drug that is very difficult to administer is castor oil. A celebrated statesman was discoursing upon this subject one day at dinner. Addressing a no less celebrated physicist, he said: "Taking castor oil is quite easy. What you have to do is to take a glass, put some water into it, then over this water you carefully pour your castor oil;

then over the castor oil you pour a second layer of water, so that the castor oil shall remain as a sort of sandwich between the two layers of water, and then you toss it off." "But," said the physicist to whom he was talking, "if you pour in a second layer of water, the oil, being lighter, will come to the top." "But it must be done with great judgment," said the statesman. The statesman was so far right that it is possible to have the castor oil between two layers of something, but the physicist was also right in so far that if you pour water over the castor oil the oil is bound to rise again to the top of the water; but if you pour in first of all a little water or peppermint water, which is heavier than the oil, then pour on your oil, and then pour over the top of the oil a little brandy, which is of less specific gravity than the oil, the oil does remain as a sandwich between the two layers, and can then be tossed off without the patient ever being conscious of its taste. It is well to wet the whole glass thoroughly before pouring in the oil, so that no oil should by any chance adhere to the glass, and thus come in contact with the lips.

Quinine is a drug that is somewhat difficult to administer also. It has a peculiar persistent bitter taste, and if you give quinine as is very often done, with a very small quantity of acid, just enough to dissolve it, the patient will probably complain of the intensely bitter taste for a length of time. The reason of this is that if there is just enough acid in the mixture to dissolve the quinine, the alkaloid is precipitated from solution by the alkaline saliva upon the tongue, and there it remains lying for a length of time and giving rise to a bitter taste. But if you dissolve the quinine with a certain excess of acid, it goes down without being precipitated by the alkaline juices of the mouth, and if you tell the patient then to drink a little water, it leaves behind a rather pleasant, sweetish after-taste, instead of a persistent bitter taste. There is one drug that has got a very peculiar action upon the mouth: it completely paralyses some of the nerves of taste. It is the leaf of a plant called the *Gymnema sylvestris*, and if you chew a little bit of this leaf, and afterwards try to taste sugar, you cannot taste it at all; you cannot distinguish between sugar and sand.

Action of Drugs on Respiration.—We may now pass on to a very important class of drugs, viz., those which act upon the respiration. Respiration consists of two parts: (1) inspiration and (2) expiration, both of which are regulated by the nerve centre in the medulla oblongata, and this centre, like most others, is kept in action reflexly. It is, however, stimulated by the condition of the blood which passes through it. Therefore we may say that the *amount* of respiratory work done depends really upon the condition of the blood in the medulla, but the *way* in which it is done depends upon reflex stimulation of various afferent nerves.

A knowledge of the action of drugs upon the respiratory centre is of very great value indeed, because it is through failure of the respiration that most people die. There are comparatively few people who die from stoppage of the heart; it is almost always through failure of the respiration, and in many cases if you can keep up the respiration for a certain length of time you may be able to get the patient round. Of course, this is most easily seen in cases of drowning or suffocation, where the respiration has been forcibly arrested for some time; and there, by the use of artificial respiration, you can frequently save your patient's life.

Artificial Respiration.—I mentioned to you a little while ago how artificial respiration could be performed. The simplest plan is to press the chest rhythmically, in accordance with your own respirations, and next to this in simplicity is Sylvester's method of raising the arms above the head, so as to expand the chest, and afterwards bringing them down and pressing them across the chest, in order to drive the air out and imitate expiration artificially.

Asphyxia.—The condition of the blood in the medulla depends, to a great extent, upon the condition of the heart, and if the heart be failing, or if the heart stop, the medulla will be stimulated by the venous blood in it. First of all there will be excessive respiration, then stoppage of respiration, and lastly general convulsions, unless the failure of respiration has been so slow that the convulsant centres have been anæsthetised by the accumulating carbonic acid.

Internal Respiration.—The interchange of gas between the tissues and the blood is usually known as internal respiration; the interchange of gas between the blood and the external air is known as external respiration. We are able to influence the internal respiration by certain drugs; for example, we find that hydrocyanic acid has the power of lessening the interchange of gas between the blood and the tissues, but this drug has also got an extraordinary power of arresting the external respiration. It affects the medulla in such a way as completely to put a stop to its function, and the respiration ceases immediately. One of the quickest modes of producing death is by the introduction of hydrocyanic acid into the organism, either through the mouth, lungs, or one of the mucous membranes. A year or two ago I was asked by one of my colleagues what he ought to do with a rat which he had got, and which he wished to make some microscopic preparations from. The rat was in a cage, but it was very wild, very vicious; it bit most furiously at anything put near the bars of the cage, and my friend did not quite know how he was to kill it, so as to make the preparations he required. I got a small subcutaneous syringe, made some strong hydrocyanic acid, and squirted a drop into the animal's eye; it simply dropped down dead instantaneously, as if it had been shot. You may sometimes be called upon to use hydrocyanic acid in order to put a favourite animal out of pain. Strong hydrocyanic acid is easily made by taking a strong solution of cyanide of potassium, and adding to it some tartaric acid, when bitartrate of potassium is precipitated, and hydrocyanic acid remains in solution. In doing this you must be careful not to prepare your hydrocyanic acid in too confined a space, because if you do you may poison yourself. I remember on one occasion trying to make it in a small room, and the fumes became so strong that I became giddy and was only able to open the door and rush out in time, otherwise I might possibly have died from the fumes. I daresay many of you remember that in the stories of poisoning in the Middle Ages it is told that St. Croix, one of the most famous poisoners, was leaning over a crucible or vessel in which he was preparing some poison when his mask broke, and the fumes poisoned him at once, so that he fell dead. In all probability he was dealing at that time with some cyanide, and the fumes which arose were those of hydrocyanic acid.

Sternutatories.—There are certain drugs which stimulate the respiratory centre reflexly, and these are known by the name of "Sternutatories" or "Errhines." These, when applied to the nose, cause violent sneezing. At one time they were very favourite remedies, but they are not very much used now. They are sometimes very useful, however, in cases of headache. They require to be employed with care, on account of the violent efforts that they occasion; and in cases of elderly people they should not be used for fear of causing the bursting of a vessel. They are sometimes employed in country practice as a substitute for the forceps in labour; the violent efforts at sneezing have the power to cause expulsion of the fœtus, and thus to save the operator the trouble of applying the forceps.

Local sedatives to the nose are a good deal used in hay fever and in commencing catarrh. A very useful one is Ferrier's snuff, which is a powder containing bismuth with a little morphine, and this may be applied to the nose just at the commencement of either hay fever or catarrh. Cocaine is frequently used as a local sedative for hay fever, and may either be employed by injection into the nostrils, by application as a spray, or by putting a drop into the eye and allowing it to flow down into the nose. Cocaine has got an almost magical action the first few times that you apply it, but it seems to lose its effect, and it is not a very good drug to use because it is very apt to give rise to the cocaine habit. Men who begin by putting a drop or two of a solution of it into the nose in order to lessen irritation from hay fever are very apt to go on because they feel the general sensations of well-being produced by cocaine, and they get more and more into the habit of taking it, until at last they are unable to do without it.

Cough.—Other drugs are used in order to lessen cough. Now, cough is a reflex act, and it is intended, like most reflex acts, for the good of the organism. I mentioned to you that the irritation of the conjunctiva which comes on when a particle of dust or a rove-beetle gets into the eye is a useful thing, because it tends to make you remove the dust, the beetle, or what-

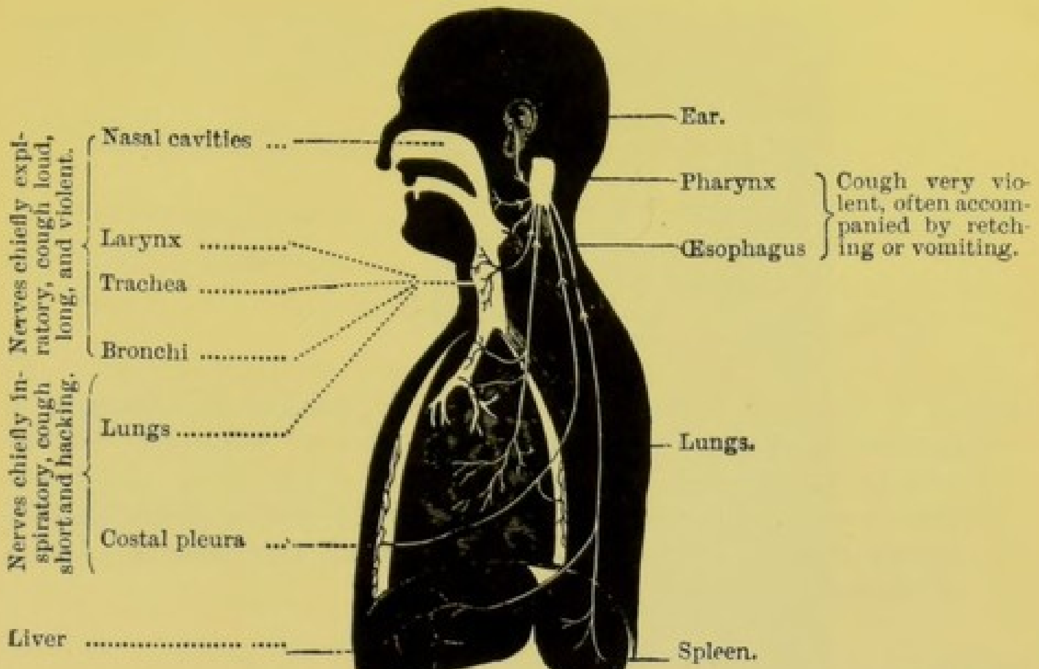


FIG. 82.—Diagram of the afferent nerves by which cough may be excited. These nerves are shown passing to the respiratory centre in the following order from above downward: from the auditory meatus, pharynx, upper part of œsophagus, larynx and trachea, bronchi, lung, costal pleura, liver, and spleen.

ever it may be, that has given rise to the irritation. But after the beetle or other irritant has been removed from the eye, you may still have a feeling as if something were there. The irritation remains, although the irritant may have been removed, and then the more you rub the worse you make it. So we find that frequently cough, although it is intended primarily as a useful action, is really injurious to the patient, because it goes on when there is nothing which can be coughed up. If a crumb gets into the trachea, " down the wrong throat " as it is usually termed, it brings on a cough which is useful by removing the irritant; but if the mucous membrane of the trachea becomes inflamed the inflammation causes irritation of the tracheal nerves and cough which is not only quite useless, but actually injurious, in the same way as rubbing the eye when there is nothing in it to remove. Remember that at one point, just at the pharynx, the respiratory and the digestive tracts cross, so that you may look upon the pharynx as being a part of the respiratory as well as of the digestive tract, and irritation of the pharynx, although it usually causes a tendency to retch and vomit, will also tend to produce cough.

LECTURE 14.

Action of drugs on respiration, *continued*—Mechanical impediments to respiration—Value of emetics—Colds—Nature's respirator—Organisms on the nose—Hay fever—Action of drugs on the pharynx—Double action of cough linctus—Vapours—Action of drugs on pulmonary secretion—Stimulating and depressant expectorants—Action of alkalies and acids.

GENTLEMEN,

At our last lecture we were discussing the action of various drugs upon the respiratory tract, and I mentioned to you that the respiration is maintained by a nerve centre in the medulla oblongata. The amount of respiratory work is determined by the condition of the blood in this centre; the distribution of the work is determined by stimulation of various afferent nerves. These nerves are so distributed that they tend to cause movements which are useful for the organism, and all the nerves that supply the upper part of the respiratory tract tend when irritated to cause violent expiratory efforts, and thus to drive out any foreign body that may have obtained entrance. The nerves that supply the deeper-seated portions of the respiratory passages tend, under similar conditions, to cause inspiratory efforts. Expiratory nerves when stimulated to their full extent tend to arrest the respiration in the state of expiration, and when less powerfully stimulated they tend to slow the respiration; inspiratory nerves, as a rule, tend to quicken it, and therefore by simply watching a patient you are sometimes able to ascertain with considerable accuracy what part of the respiratory tract is affected by disease. If you find that the respirations are much accelerated, you may be almost sure that the irritation is not confined to the bronchi, nor to the trachea, but affects some portion of the

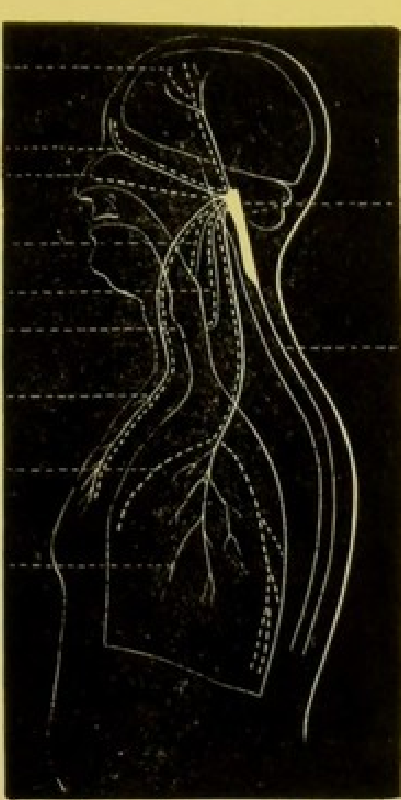


FIG. 83.—Diagram showing the position of the respiratory centre, and the afferent nerves which influence it. Inspiratory nerves are indicated by plain, and expiratory by dotted, lines.

lung itself. The reason is, that irritation of the bronchi, which are supplied by the expiratory, *i.e.*, slowing, nerves of respiration, tends to make the respiration slow, while irritation of the lung substance itself tends to render the respiration quick.

Now, respiration may fail from various causes. It may fail from (1) weakness of the respiratory muscles, or (2) weakness of the respiratory centre, or (3) some mechanical impediment to the expansion of the lungs.

Mechanical Impediment to Expansion of Lungs.—We find that occasionally a mechanical impediment to the expansion of the lungs is caused by effusion of fluid into the pleural cavity, and in order to relieve this the fluid must be removed; we find it also from the accumulation either of fluid or of gas in the abdominal cavity. This, in the first place, acts by pushing the diaphragm up, and thus encroaches upon the space that ought normally to be occupied by the lungs; and, in the second place, offers a great impediment to the descent of the diaphragm during inspiration. The amount of gas in the intestine or in the stomach is sometimes sufficient to interfere seriously with respiration, and you will not unfrequently find that people who are simply suffering from flatulence come to you describing symptoms which appear to point to disease of the heart or respiration.

Position.—When there is difficulty of breathing, even the normal weight of the viscera may tend to increase the patient's dyspnœa still further, and on this account we find, when the breathing is difficult, the patient tends to assume a certain position. Ordinarily people who are not suffering from difficulty of respiration when resting in bed lie upon their back or upon one or other side, but when the difficulty of breathing is great, or when the difficulty of aërating the blood is great from failure of the heart, the patient tends to assume an upright position. You can easily see the reason for this from the diagram which I give of a patient lying in bed (Fig. 84). Each time the diaphragm descends in order to increase the cavity of the thorax and draw air into the chest the viscera must be lifted. The higher line

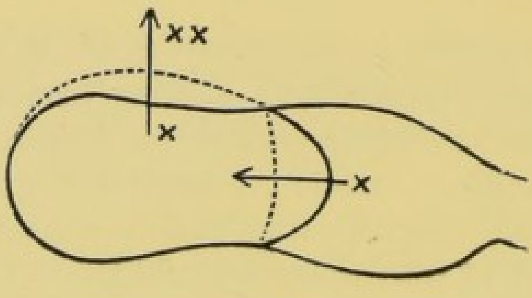


FIG. 84.

indicates the position of the abdominal walls during inspiration, and to obtain such a curve as represented the viscera must really be lifted up, so that each inspiratory movement of the diaphragm has to overcome the weight of the viscera, and this tends to interfere with respiration. If the patient, on the contrary, sits up, at each inspiratory movement of the diaphragm the viscera only require to be pushed forwards, so there is no weight to overcome, and you see that patients who are suffering from difficulty of breathing assume the position usually known as orthopnœa (Fig. 85). When there is much distension in the

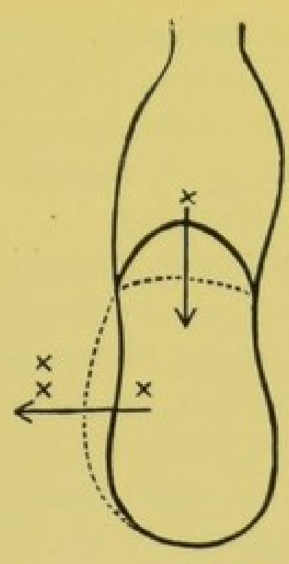


FIG. 85.

abdominal cavity, you have, of course, to remember that by removing the wind, or by tapping the peritoneal cavity and allowing the water which is present in it to drain away, relief will be afforded.

Pressure on Chest.—I daresay some of you may remember the story of Molyneux, the famous pugilist, whose torso was such a model of symmetry that some artists were very anxious to take a cast of it. Accordingly they poured a large quantity of plaster of Paris over his whole chest and abdomen. The unexpected result was that Molyneux very nearly died, and they had to break up the plaster before it had completely set, because in setting the plaster became perfectly hard, so that the thorax could neither expand nor contract, and the abdomen being also fixed by the plaster, the diaphragm could not move, so that Molyneux was very nearly suffocated. Now this is a little incident that is worth bearing in mind, because, although you are not likely to repeat the experiment, yet you may unwittingly do the same thing to a less extent. Occasionally you may find that when patients have great difficulty of breathing even the weight of a poultice encircling the chest tries them considerably, and although you may wish to apply a poultice all round the chest for the sake of warmth, yet it may sometimes be better to dispense with the poultice and to put a thick layer of cotton wadding instead. I reminded you of the danger of interfering with the respiration in cases where you are giving anæsthetics, and warned you that it is inadvisable to allow the chest to be pressed upon either by stays or other articles of dress, or by the arms of stout dressers who are holding the patient down to prevent struggling.

Plugging of Nose, Trachea, or Bronchi.—We may get interference with the passage of air to the lungs in other ways by more or less complete plugging of the respiratory tract in its various portions. We find this not uncommonly in the case of the nose, where the mucous membrane becomes thickened in consequence of inflammation, or where there are post-nasal growths that interfere with the passage of air. The presence of post-nasal growths is not unfrequently recognised by the fact that the patient acquires a vacant look, because, being unable to breathe through his nose, he holds his mouth gaping open "as if he were catching flies." Another common consequence of thickening of the mucous membrane and inability to breathe through the nose is dryness of the mouth, which interferes much with the patient's comfort. The mouth in the morning becomes so dry that the tongue almost resembles a piece of leather, and this is a symptom which patients lay a great deal of stress upon, and which, unless you think over the causation of it, might puzzle you a good deal. In the larynx you may meet with obstructions, due, for example, to the presence of a false membrane in cases of diphtheria, or you may have mechanical interference by the presence of pieces of food. I remember on one occasion seeing a poor woman suffocated by a piece of gristle which she had swallowed, and which stuck in the larynx and completely occluded the air-passages. Formerly in order to remove false membranes emetics were not unfrequently employed. They had the effect of causing violent expiratory efforts, during which the membrane was expelled. The emetic most frequently used was ipecacuanha, in doses of 1 drachm of the wine, frequently repeated, or the sulphate of copper or zinc. Twenty grains of sulphate of zinc or 10 grains of sulphate of copper are a dose for an adult, and accordingly if the patient were a child you would calculate the dose from the table I gave you some time back. Another useful emetic is alum, and I have seen a child bring up a diphtheritic membrane, which was occluding its larynx, after the administration of a teaspoonful of honey stirred up into a thick paste with powdered alum. In this case ipecacuanha had completely failed to produce any effort of vomiting at all. This simple remedy is one that you may be able to get when other things are not at hand. Latterly the use of these drugs has not been so common as formerly, because now we administer the diphtheria antitoxin, which seems really to have the power of making the membrane melt away. The membrane may also be removed mechanically by means of sponges tied to the end of a piece of whalebone, or by simply brushing it away, but frequently the membrane gets so low down that it is quite impossible to reach it, and even when you can reach it it is not advisable, as a rule, to use much force in brushing it away. In the trachea we do not meet with mechanical obstruction, as a rule, to any great extent, except from external pressure by new growths, by aneurisms, and occasionally perhaps by excessive growth of the thyroid gland. In the large bronchi also we do not, as a rule, meet with obstruction, except that due to pressure from without, as in the case of aneurisms or new growths. When you come to the smaller bronchi you very often get great obstruction either from thickening of the mucous membrane by congestion or from the presence of more or less thick mucus within the bronchi themselves. You can readily see why the large bronchi should not suffer very much from thickening of their mucous membrane, or at least why the passage of air through them should not on this account be greatly interfered with. Let A (Fig. 86) represent a section of a large bronchus, and A^1 its normal mucous membrane, and let B represent a small bronchus, and B^1 its normal mucous membrane. Suppose you thicken the mucous membrane in both cases to double the normal, A^2 and B^2, then in the case of the large bronchus no doubt you obstruct to a certain extent the passage of air through it, but there is still an opening quite sufficient to allow a fair quantity of air to pass, and so the comfort of the patient is not materially interfered with. But if you double the thickness of the mucous membrane in the case of a small bronchus, B, you may almost

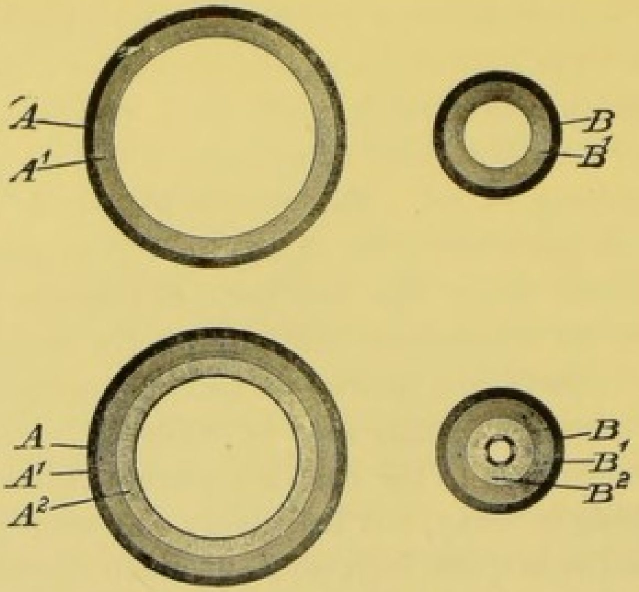


FIG. 86.—Diagram to illustrate the effect of swelling of the mucous membrane in large and small bronchi.

completely occlude it, and so ultimately shut off the passage of air to the portion of the lung to which the bronchus is distributed. So that, as a rule, you do not get very much interference with respiration directly from congestion of the trachea or large bronchi, but when the congestion of the mucous membrane occurs in the small bronchi you have very great interference with respiration indeed, and the utmost dyspnœa may result. Moreover, you can readily see that if, in place of lessening the lumen of the small bronchi by thickening of the mucous membrane, you lessen the lumen by contraction of the muscular fibres in the bronchial wall, you get a somewhat similar effect, and so in spasmodic asthma, which probably depends chiefly upon contraction of the involuntary muscular fibre in the walls of the bronchi or bronchioles, you sometimes get the utmost dyspnœa, which, after continuing for a certain length of time, will suddenly cease, and the patient appear to be perfectly well again. Now in the case of the trachea or large bronchi exudation in the form of mucus into their lumen also interferes to a very slight degree only with the passage of air, but just as thickening of the mucous membrane obstructs or entirely occludes the lumen of the small bronchi, so the presence of a little exudation will prevent or impede the passage of air through them. Then, again, if you have a catarrhal condition passing down from the smaller bronchi into the lobules of the lung, you may get the lung becoming functionally inactive over a great part of its extent. The same result may come about, not from a catarrhal condition, but from a croupous condition of the lung, where, in place of getting proliferation of epithelium, you have an exudation of lymph and fibrine into the alveoli, as in cases of acute pneumonia, and there also you find that the aëration of the blood is greatly interfered with.

Nervous Derangement.—You may sometimes find that the movements of the chest are impeded by nervous disturbance and not mechanically in the way we have just described, either from pressure outside or from obstruction inside the air-passages. For example, when there is much pain in the chest, whether this be due simply to pleurodynia or pleurisy, the movements of the chest are often imperfect.

Colds.—When we find that there is much congestion in the bronchi we have recourse, as a rule, to what are termed respiratory sedatives. In cases of disease, our first attempt is, if possible, to avert or remove the cause of the disagreeable symptoms—to prevent the disease or cure our patient—but if we cannot remove the cause the next thing we try to do is to relieve the symptoms. In the case of colds something may occasionally be done in the way of averting them. Most of you know that common colds are usually said in households to be infective, so that they are often brought home by children who have caught them at school, and if a cold gets into a house it is very likely to run through the whole household before it stops. Unfortunately, common colds do not afford the protection that certain other diseases, such as small-pox, do, but if a person has had a cold and gets rid of it, he is very apt to have a recurrence. So that, if a catarrh gets into a house, you may get it going round and round the family, and the last member is no sooner finished with it than the first one begins again.

Now, it is always well to be very careful in regard to the introduction of infection by a "common cold." I have seen an old lady who was kept by her family carefully protected from every possible source of injury. She was very dear to them, and they took every precaution they could for her safety. There was not a draught allowed near her; she was kept in two rooms, and simply went from one to another, and for months she remained perfectly well. But one day a friend with a bad cold in her head called upon this old lady, and the next day she had a bad cold, which passed down into her bronchi and became a source of very great danger. Now, in her the microbes probably found a suitable soil, which in healthy people they might not have done. But even in healthy people the mucous membrane of the bronchi may first be temporarily weakened and rendered liable to infection. In regard to this it is well for you to remember a passage which you will find in the book of Genesis: "God breathed into man's nostrils the breath of life, and man became a living soul." Man very often forgets this; he begins to breathe through his mouth, and he dies. The nostrils, as you know from your anatomical studies, form part of the respiratory tract; the mouth has no business to form part of the respiratory tract. It never was intended for respiration; it was intended for mastication and deglutition. Now, I mentioned to you before that if you take a fowl which is immune from anthrax and inoculate it with anthrax in the ordinary conditions, you get no result, but if you stand that same fowl with its feet in water for a certain length of time so as to chill it down and then inoculate it, it becomes infected with anthrax. What happens to the tissues of the fowl happens also to the tissues of human beings, and when they are chilled down they seem to have much less power of resisting the attacks of microbes than when they are in a healthy condition. In the case of the trachea and bronchi, the tissues are, to a great extent, protected from being chilled down and from affording a suitable soil for microbes by the arrangement that we find in the nose.

In the nose we find that the turbinated bones are arranged in the same way as the plates of iron in some of the new stoves, *i.e.*, in a kind of spiral. By this means they afford a large heating surface, so that the air passing over the turbinated bones, covered as they are with mucous membrane containing a large quantity of blood, becomes warmed before it gets down into the trachea or into the bronchi. Moreover, there is a little peculiarity in the attachment of the mucous membrane to the turbinated bones, to which my attention was once very particularly directed, for when I was examined in anatomy for my "pass" this question was put to me: "What is the mode of attachment of the mucous membrane to the turbinated bones?" and I am sorry to say that I did not know. But the proper answer to the question would have been, "The mucous membrane is attached to the turbinated bones by a very loose connective tissue." Now, you can readily see why it should be so. It did not occur to me then, but it is clear now, that if the mucous membrane were attached to the turbinated bones by tight connective tissue it would not be able, when the vessels were turgid and full of blood, to swell out, and this would mean that when the external air was very cold it would not get sufficiently warmed on its passage through the nose. But by its being very loosely attached to the turbinated bones the mucous membrane in the nose becomes almost an erectile tissue, and allows the blood to course exceedingly freely through it, and thus on a cold day the air gets well warmed by passing through the nose.

Respirators.—In those cases where the mouth is not kept shut, and consequently the air is not warmed as it goes down into the trachea, it is sometimes advisable to prescribe respirators. The respirators usually worn sometimes cover the mouth only, and this is often sufficient. Sometimes patients can be persuaded to wear respirators covering both the mouth and the nose, but a great many people will not wear them, and they are much less in vogue now than at one time. There is, however, one kind of respirator that patients who object to the others will wear, and that is an invisible one. Many patients do not like the look of a respirator, but they will wear one that cannot be seen. The original invisible respirator consisted, I believe, of a plate of metal which was placed between the teeth and the lips, and so, in order to keep hold of it, the lips were permanently closed, and the patient was unable to open the mouth either involuntarily, to take a deep breath, or voluntarily, for the purpose of speaking, without being reminded of the fact that the mouth was open by having to take the respirator out. A shilling will do just as well, but a sovereign is still better, because the patient is more afraid of losing it, and it impresses upon him more strongly the necessity of keeping his mouth shut. Of course the use of a respirator is quite unnecessary if a patient will keep his mouth shut, but there are a number of patients who either will not or cannot keep their mouths shut, nor will they wear a respirator, not even an invisible one. For them I think one of the best means you can adopt is to insist upon their wearing one of those loose "clouds" as they are called, or Shetland shawls, drawn over the nose and mouth. By this means you greatly diminish the risk they run of getting unwarmed air into their trachea or bronchi.

Organisms in the Nose; Hay Fever.—Sometimes, in spite of the freedom with which the blood passes through it, the nasal mucous membrane itself affords a good soil for various organisms, and occasionally some of the worst cases of bronchitis begin with a cold in the head. Organisms seem to find a nidus in the nasal mucous membrane, where they grow, multiply, and flourish, and gradually spread down the throat until they reach the trachea and the lungs themselves. Nor is it merely pathogenic microbes that find a nidus in the nasal mucous membrane. When the pollen of a plant reaches the stigma the pollen grain becomes moistened, sends down the pollen tube through the tissue of the stigma to the ovary (Fig. 87), and fertilises the

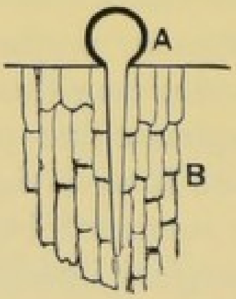


FIG. 87—Pollen grain A sending down a pollen tube through the cellular tissue of the stigma of a flower.

ovule. Now when a pollen grain falls upon the mucous membrane of the nose in many people it seems to make a mistake and behaves as if it had fallen upon the stigma of a plant, for it sends out a pollen tube, which penetrates into the mucous membrane, sets up irritation, and gives rise to the condition known as hay fever. One of the best ways of avoiding hay fever is to keep away from flowers, because it is not merely the pollen of grass that we have to consider: the pollen of many flowers will do it, and simply a few flowers in the house in flower-pots or in glasses on the table may keep up hay fever in people who are liable to it without their ever suspecting the cause. So when you are dealing with patients who suffer from hay fever try to keep pollen out of their noses by every means in your power. There is another method, however, and that is to try and render the mucous membrane of the nose a bad soil for the pollen, and this you may do, to a certain extent, by thoroughly greasing the inside of the nose as far as you can reach with some sticky ointment. One of the best perhaps is zinc ointment, because it does not melt away so quickly as other ointments, and it forms a twofold defence to the nose: first of all, it is a sticky thing, and the pollen as it enters the nose will tend to be arrested on the surface of the zinc ointment, and not to go further into the nose; and secondly, it does not afford a soil on which the pollen tubes can germinate, and so those that do fall upon the zinc ointment become harmless. In some cases I have known this very simple arrangement almost completely prevent attacks of hay fever in men who were very liable to it. Other ointments answer, but they do not act so well, because they are not so thick and sticky, and they melt away sooner than the zinc ointment does.

As I mentioned to you before, when there is great irritation caused by the hay fever, you may lessen this irritation by means of cocaine; but one tries to avoid the use of cocaine as far as possible in order not to induce a habit. You may also do a considerable amount of good by washing the nose out with a weak solution of some antiseptic. Thus, for example, it is recorded that Professor Binz cured the great physiologist, Helmholtz, of hay fever by washing his nose out with a half per cent. solution of quinine. A one-half per cent. solution is practically a saturated solution of the sulphate of quinine, because if you add sulphate of quinine to water without any excess of acid, the water does not dissolve more than a half per cent., and this, used as a lotion to the nose, will tend to wash out any organisms or any pollen grains and thus prevent hay fever. A similar result may be obtained by using a weak solution of carbolic acid, say one part to 500. In using solutions to the nose it is well to bear in mind that pure water is a strong irritant to the tissues, causing much pain to a cut surface, and to a less extent, is an irritant, to mucous membranes. Normal saline solution (six parts of common salt to 1,000 of water), on the contrary, is not an irritant either to an exposed muscle or to a tender mucous membrane; and the addition of a small quantity of chloride of sodium to the water will tend to lessen any irritation in the nasal mucous membrane which might otherwise be produced. I find I always forget the quantity I have to prescribe, and the way in which I remember is simply this: practically we may say that an ounce contains 500 minims, and we want half a grain of salt for each 100 minims, so that 5 half-grains or $2\frac{1}{2}$ grains of chloride of sodium is the quantity required for each ounce of your solution.

Pharynx.—I come now to the action of drugs upon the pharynx. As I mentioned to you before, the pharynx forms part both of the respiratory and of the digestive tracts, and you can sometimes stop a cold before it has got down to the trachea if you catch it at the pharynx. There are some colds which, as I have said, begin in the nose and travel down to the lungs, but there are others that begin in the pharynx and travel upwards into the nose and downwards into the chest. These you may sometimes stop by simply brushing out the pharynx steadily with some antiseptic solution and by gargling with an antiseptic solution. One of the best of these solutions for gargles that I know of is about half a drachm of carbolic acid to 6 ounces of rosewater. This makes a very nice gargle, but you must take the precaution of inquiring of your patients beforehand whether they can gargle or not without swallowing, because carbolic acid when swallowed is a dangerous poison, and it would be possible for a patient to swallow sufficient of such a gargle to produce symptoms of poisoning. In cases where gargling without swallowing is impossible you can prescribe chlorate of potash and borax; such a gargle we have in the Hospital Pharmacopœia, viz., 3 grains of borax, 6 grains of chlorate of potash, 10 minims of tincture of myrrh, and distilled water up to 1 ounce; but not unfrequently one uses 10 grains of each to an ounce of water. Many people now, instead of using gargles, which can only be employed at certain times in the day, unless the patient is confined to the house, employ tablets of compressed borax or of compressed chlorate of potash, or a mixture of the two together, or of compressed chloride of ammonium or of nitre, and will put one of those into the mouth and suck it occasionally. This mode of using the antiseptic is perhaps the best, because it thus gets applied during a great part of the day to the pharynx, and this is a matter of considerable difficulty in the case of brushing, spraying, or gargling.

Mechanical Action of Cough Linctus.—You will find that a number of drugs that are used to lessen cough seem to do this merely in virtue of the sedative action they exert on the throat. It appears to me that the cause of this very frequently is that cough, like other reflex actions, is due to what is termed the "summation of stimuli." The simplest example of summation of stimuli that I know is what occurs so frequently at school, when one boy tells another that he will run a pin into him, and the second boy says, "You can do it, and I won't jump." Accordingly A runs a pin into B, and B does not jump, but if C runs a pin into B at the same time as A, the summation of stimuli takes place, with the result that B does jump. In the same way, if you get an irritation of the trachea, bronchi, or lungs, it may not be sufficient of itself to produce cough, but if you have an irritation in the throat or in the stomach as well, cough is produced. If you can relieve the irritation either in the throat or in the stomach, leaving only the irritation in the trachea, bronchi, or lungs, you may stop the cough. Now this is what seems to happen with drugs that are used in order to lessen cough by their action upon the throat. One of the most common of those is the old-fashioned extract of liquorice, commonly known as Spanish liquorice. This does not seem to have any physiological action excepting that it stimulates the salivary glands, and thus keeps the back of the throat well lubricated with saliva. We have also a variety of jujubes and various lozenges, a great many of which are simply lubricants, and nothing more. In the case of that class of medicine known as "Linctus," we have two factors at work: we have some sticky lubricating material, and we have also, in addition, some drugs which will have a tendency to lessen irritation. We have two or three in the Pharmacopœia of this Hospital, all of which are much used. The first one is the common linctus, in which we have tragacanth powder and tincture of hips, simply in order to make a thick lubricating material which will stick well about the fauces, and diminish irritation there, and at the same time will afford a good vehicle for the syrup of poppies and the vinegar of squills, which are the active ingredients. Many of you may know that this linctus used to be made very much thicker than it is now, and very likely the thicker linctus was more efficacious. The reason why it was made thinner was this. It was discovered that a large number of children came to the surgery complaining of cough, and they were given linctus, but, instead of their using it as a medicine, they took it to an old woman out in Smithfield, who gave them each a penny, took their linctus, and made jam tarts of it. We have also another linctus which is very much used, containing compound tincture of camphor, oxymel of squills, and syrup of tolu. These oxymels are useful in cases of cough, because the honey which they contain makes a very good lubricant for the throat.

Irritation in the Trachea.—With regard to the trachea, we find that irritation in it can very often be lessened to a great extent by the use of a cold compress, or by the use of a poultice. The difficulty about applying poultices to the neck is that they are so very apt to get cold before they can be taken away; thus they are not only more troublesome to make, but less comfortable to keep on for a length of time. In consequence of this one frequently recommends the use of a cold compress to the throat. This is made by simply dipping a piece of lint in cold water; it is then put round the throat, covered with a bit of gutta-percha tissue or oiled silk and then over this a stocking, or, what is still more convenient, a larger piece of lint, is put, and fastened with safety-pins. This is an exceedingly useful application in cases either of sore throat or of irritation in the trachea.

Vapours.—We may apply also to the trachea and to the bronchi vapours of various kinds. One of the simplest of these is the vapour of hot water, and this is often given simply from a jug, the patient inhaling it from the mouth of the jug, a towel being thrown over the head to keep the vapour in. We may medicate the vapour, and one of the most common drugs used for this purpose is the old-fashioned Friar's balsam—the compound tincture of benzoin—a teaspoonful of this being thrown into a pint of water, and then the vapour inhaled. You will see that in the Hospital Pharmacopœia it is recommended that the temperature of the water should be about 150°, and that there should be a pint of it. The reason for using so much as a pint simply is that it does not get cold so soon as if you took a smaller quantity. The simplest way of obtaining water at 150° F. is to mix two parts of boiling water with one part of cold. The inhaler I show you is one which may be used for inhalation. It consists simply of a large jug which is placed upon a stand, and underneath this may be put a spirit lamp, so as to keep up the temperature. Passing down into the jug is a long tube, open at the lower end. This tube should pass right down into the water which the vessel contains. Coming out from the top of the cover is a wide tube with a nozzle at the end; this the patient is expected to take into his mouth and inhale from, there being fixed to it a small indiarubber valve, which allows the expired air to pass out freely, but which prevents air from being sucked in during inspiration. This is a very useful apparatus, but it is one that very few people ever use; it is too complicated, and, as a rule, the jug alone is preferred to anything else.

We have various other substances that have a still more stimulating action upon the bronchial mucous membrane than the tincture of benzoin, for example the oil of Scotch pine, forming the vapour *Olei pini silvestris.* Then we have the vapour of pure terebene, and so on. In the case of oil of

Scotch pine, of pure terebene and also of creosote, some light carbonate of magnesia is added. The reason for this is that if you pour creosote, or oil of Scotch pine, or terebene into water pure and simple, the oily substance remains in large globules, and will not diffuse equally through the water, but if it is triturated with a little light magnesia and then poured into the water it becomes equally diffused in it, and the vapour is given off much more freely. We have in the Pharmacopœia typical examples of several kinds of inhalations. The vapour of creosote is mostly used when we wish to apply a disinfectant to the bronchi, *i.e.*, a substance which will tend to destroy any microbes. The oil of Scotch pine or terebene is used more in cases where there is a good deal of irritation and excess of secretion; they tend to check secretion to a considerable extent. The vapour of benzoin is used more for its sedative effect upon the bronchi and mucous membrane, so that one employs it in cases of acute bronchitis where there is a good deal of irritation, and especially when the patient complains of pain over the bronchi.

Action of Drugs on Pulmonary Secretion.—We now come to the effect of various drugs upon secretion from the respiratory passages. Warm vapour tends to cause increased secretion from the bronchial mucous membrane, and thus to make the mucus come away more easily than before. The other conditions that I have just mentioned frequently have a somewhat similar action, and, while making the mucus less viscid, tend at the same time rather to lessen the secretion, so that after awhile mucus does not come away in such large quantities.

Expectorants.—There are various drugs, however, which have a direct action upon the bronchial mucous membrane, increasing the secretion or rendering it more fluid, and we have thus a class of drugs which are known as expectorants. Expectorants are divided into two classes: (1) the so-called depressant and (2) the so-called stimulating. These have not got their name from their effect upon the respiratory centre, but from the effect they have upon the circulation. The depressant expectorants tend to cause a feeling of general weakness and frequently nausea; they render the pulse more feeble than before. Perhaps the three most marked expectorants of the depressant class are antimony, ipecacuanha, and apomorphine. Ipecacuanha is one that is very commonly used indeed, and it may be given, for example, in the form of the vinum ipecacuanhæ in doses of 10, 20, or more minims, repeated at such intervals as may seem necessary. Its action is to render the secretion from the bronchi more watery, and to make the spit come away more freely. Antimony has, to a great extent, gone out of fashion, but it is still one of the most powerful expectorants that we possess. If you know how to use it, you can sometimes get exceedingly good results from it. Apomorphine has a similar action to both of the former. Perhaps I may just give you an example of the action of antimony. A very pious lady was in what is termed "retreat," and she used to go to chapel every morning early. The chapel was very cold, and she knelt upon stone floors. She was a lady who had been delicately nurtured, and, as a result of her early devotions, she got a severe cold. On examining the chest, I found that there was no indication of any secretion. There were all the indications that one could desire of congestion of the smaller bronchi, and I have no doubt that the mucous membrane of the smaller bronchi was very greatly thickened; she had consequently a good deal of difficulty in breathing, and a dry, troublesome cough; further the whole chest was filled with dry râles. There were no moist râles whatever and no sputum. On giving her the antimonial wine in 10-minim doses combined with liquor morphinæ hydrochloratis, also in 10-minim doses, the cough became less, the dyspnœa became less, the dry râles in the chest were succeeded by moist crepitant râles, and sputum began to come away pretty freely. Under these circumstances I thought I had given her sufficient antimony, so I stopped it, and gave her the haustus acidi nitrohydrochlorici of the Hospital Pharmacopœia.* In a very short time a change

* Acidi nitrohydrochlorici dil., ♏x.
Tincturæ aurantii, ♏xx.
Aq. chloroformi, ad ℥i.

occurred. The spit that she had been bringing up pretty freely got very much less, it became much thicker, and came away with much greater difficulty. On auscultation of the chest, I found that the moist râles had diminished, and the dry râles very much increased. The lady's distress had, to a very considerable extent, returned. I stopped the acid, went back to the antimony, and again she got relief. When the expectoration had begun to get rather less under the influence of the antimony, I gave her simply some bicarbonate of potash. This did not check the secretion, but allowed it to go on. At the same time one did not get the nausea which would have made itself evident under the continuous administration of antimony. After she had been some days on the alkali the moist râles and expectoration began to diminish, and when the acid mixture was again begun it appeared to hasten the process of cure, and did not cause any recurrence of the disagreeable symptoms.

Alkalies increase, Acids diminish, Pulmonary Secretion.—I have just mentioned two classes of drugs which are very powerful in affecting the secretion from the bronchi, viz., acids and alkalies, and they seem to affect, not merely secretion from the bronchi, but even the lung itself, especially in cases of phthisis. You will find that in many people who suffer from phthisis, for example in those cases where the injury to the lung is confined to a small cavity, the patient every now and then, as he says, "gets cold." On examining the lung, you find that the area of dulness to percussion is somewhat increased round the cavity, that the area of broncophony is correspondingly increased, and, lastly, that crepitations are absent. You have, in fact, all the signs of a limited pneumonia occurring just around the cavity. When this happens, perhaps the best treatment is, after a day or two, to give the patient some alkali, which may be given freely diluted, and best in the form of bicarbonate of potash or citrate of potash administered as a kind of lemonade. Under this you will notice that the dry bronchial sounds gradually lessen, crepitation appears, and the patient begins to expectorate. If now you give haustus acidi nitrohydrochlorici, the expectoration will become less, but the patient will have greater difficulty in bringing it up, and will accordingly suffer more discomfort. If, however, you wait until the crepitation round the cavity is beginning to diminish of its own accord, and the expectoration to get less, and then put the patient upon the acid, he goes on improving steadily, whereas, if you put him on the acid too soon, you do him harm instead of good.

LECTURE 15.

Expectorants, *continued*—Iodide of potassium—Squill—Emetics—Application of drugs to respiratory passages—Insufflators—Sprays—Nasal douche—Nebulisers—Stomach cough—Respiratory stimulants—Mode of action of strychnine—Oxygen—Administration—Respiratory sedatives.

GENTLEMEN,

At the end of last lecture we were discussing the effect of acids and alkalies upon the secretion from the bronchial mucous membrane, and also their effect upon consolidation in the lungs which is just breaking up. I mentioned to you in this connection that acids seem to have the power of drying up the secretion, whereas alkalies, on the other hand, tend to accelerate it. Now, in addition to acids and alkalies, we have certain salts which tend to act very remarkably upon the bronchial mucous membrane, and one of the most potent of these is iodide of potassium. This drug, when taken in small doses, tends to cause great secretion from the nose, so that persons who are taking it very often return in the course of a few days after you have prescribed it to tell you that they have had a very bad cold in their head ever since they saw you. Iodide of potassium does not merely increase the secretion from the nasal mucous membrane: it tends to make the mucous membrane of the trachea and bronchi secrete more freely, and to produce a more liquid mucus than it did before. In consequence of this, iodide of potassium is sometimes a very useful expectorant in cases where the expectoration is thick, viscid, and brought up with difficulty.

Iodide of Potassium.—There is a very curious point to be noticed about the action of iodide of potassium, viz., that, while small doses and moderate doses tend to cause very profuse secretion, large doses do not, so that the probability is that if you give a patient 2 grains of iodide of potassium three times a day, he will get an exceedingly bad cold in his head; if you double the dose and give him 5 grains, the probability is that his cold will not be quite so bad; and if you raise the dose to 10, 20, or even 30 grains three times a day, the patient will have no cold whatever. The large dose seems to arrest the secretion which the small dose brings on so profusely. You must bear this in mind in dealing with the lungs, so that you must not think that you can decrease the tenacity of the mucus still further by increasing the dose. The best results in this direction are most likely to be obtained with a small dose of iodide of potassium, say from ½ grain to 2 grains three or four times a day.

There are, as I mentioned to you, two distinct classes of expectorants, the one having the power of depressing the circulation, and the other of increasing it. Those that belong to the depressants nearly all render the fluid secreted thinner than before, for example antimony, ipecacuanha, iodide of potassium, and apomorphine. Jaborandi and pilocarpine have also been employed for the same purpose, but they are not so much used as the other drugs I have just mentioned.

Amongst the stimulating expectorants, we have various drugs which tend rather to dry up the mucus in the bronchial tubes at the same time as they stimulate the circulation; they further have the power of stimulating the respiratory centre, and thus increase the respiratory movements. One of the most common of the stimulating expectorants is carbonate of ammonia in doses of 2, 3, 4, or 5 grains. Then there are various substances belonging to the class of terebinthinates. I have already had occasion to mention some bodies of this class which are used as local applications, viz., oil of Scotch fir, pure terebene, and so on. Terebene is frequently employed internally, and is usually given in doses of 3 to 5 minims enclosed in a capsule, the taste of the drug being rather disagreeable.

Squill.—We have also certain drugs which tend to act upon the circulation, and one of the most commonly employed in cases of respiratory disease is squill. Squill contains an alkaloid, scillain, which has an action very much like digitalis: it tends to stimulate the respiration, to dry up the secretion, and at the same time to increase the force of the heart. In cases where the respiratory process is clogged and impeded by abundant watery expectoration you may sometimes lessen the quantity not only by giving acids, but by giving atropine. Atropine has the power of drying up secretions from most of the mucous membranes; it renders the skin dry, the mouth dry; it arrests the secretion of the pancreas, and to a great extent it also arrests the secretion from the bronchi; and occasionally I have seen, in cases where there was a large amount of fluid mucus secreted from the bronchi, the fluid become less, the expectoration diminish, and the patient become greatly relieved by the administration of belladonna.

Emetics.—Now, you will remember that whenever you dry up the expectoration you tend to make it more viscid, and you may perhaps increase the strain upon your patient, because it requires greater efforts in coughing to bring it up. But at the same time, when you find your patient is becoming suffocated by the quantity of fluid secreted by the bronchial tubes, you had better dry it up if you can. Often, however, you cannot do this, and then you try to bring it up, and if, as sometimes happens, especially in elderly people, the ordinary efforts at coughing are not sufficient, you have recourse to an emetic. In vomiting, as you know, very deep inspirations occur, which are succeeded by very violent expiratory efforts, much more violent even than in coughing, and it not unfrequently occurs that during the efforts at vomiting a large quantity of mucus is brought up from the lungs which coughing failed to remove, and thus an emetic may occasionally save your patient. The emetic that you would choose depends a good deal on the age of your patient. You may use such a one as I have mentioned before in speaking of diphtheria, viz., alum rubbed up with honey, but most commonly you employ one or other of two emetics, either ipecacuanha or carbonate of ammonia. In cases in which the mucus is very thick, unless you make it a little more fluid you will have difficulty in getting it up. Under these circumstances the most useful drug is vinum ipecacuanhæ in teaspoonful doses every quarter of an hour until vomiting is induced. But where you find the patient in a weak condition, where the pulse is tending to flag, and more especially in old people where you find congestion of the bases of the lungs, carbonate of ammonia given in doses of about 10 or 20 grains, dissolved in water, is very useful; by its means the mucus is generally brought up during the efforts of vomiting; further the subsequent effect of the carbonate of ammonia upon the circulation as a stimulant tends to counteract the depression produced by the efforts of vomiting.

Application of Drugs to the Respiratory Passages.—I must now show you some of the pieces of apparatus that one uses in order to apply drugs to the respiratory passages. I have already shown you the inhaler for ordinary water, or such drugs as the vapour of benzoin or oil of Scotch fir. Here is another inhaler which is sometimes very useful, and is for the purpose of applying the vapour of chloride of ammonium to the respiratory passages. We have two tubes, both of which have an opening in them, and into these are put two little cylinders of carbon, one of them being moistened with ammonia, and the other with strong hydrochloric acid. These are then fitted into a small glass receiver, and from this receiver the patient sucks. The receiver refills itself from the external air, which, however, *en route* to it, passes through the tubes containing the carbon cylinders, and carries down into the receiver, the vapour of ammonia and hydrochloric acid. These combine to form chloride of ammonium, and so it comes about that the patient sucks from the receiver not air only, but the vapour of chloride of ammonium. This occurs in the form of a white cloud, and, in order to prevent any irritating vapour of the acid or of the ammonia from passing unchanged into the lungs, the chloride of ammonium vapour is washed by being sucked through a wet sponge. You observe that, on drawing air through the mouthpiece, the fumes of chloride of ammonia are formed in large quantities in the receiver, and can then be sucked out, so that they pass either into the mouth and nose or, if you inspire deeply, down into the lungs. This is sometimes a very useful inhaler, more especially where you have got chronic catarrh affecting the upper part of the tubes, trachea, larynx, and large bronchi. It is also useful in acute cases of colds, where these parts are affected while the smaller bronchi are free, and where, to your great astonishment, you detect no abnormal sound when you put your ear to the chest, and yet the patient is tormented with a distressing cough, often accompanied with a good deal of hoarseness.

Insufflators.—For the application of powders to the nose we use insufflators. I show you here one form of insufflator. It consists of a bent tube, to the end of which is attached an indiarubber ball; in the side of the tube there is an opening. You place the powder you desire to use in the opening; this is then closed by a wide ring, which can be slipped along the tube at pleasure; the nozzle of the tube is placed well back in the pharynx, and just as the patient takes a breath the indiarubber ball is pressed, and the powder is blown down into the larynx. This mode of treatment is sometimes very useful indeed in cases of laryngeal phthisis. In fact, I do not know that there is any method of treatment which gives more comfort in cases of laryngeal phthisis than the local application of morphine to the larynx in small doses. Generally you use only about $\frac{1}{12}$th of a grain of morphine, and this being too small to apply by itself, you can dilute it with either a grain or a couple of grains of starch or with 2 or 3 grains of carbonate of bismuth. A mixture of starch, bismuth, and morphine is also a very useful application in hay fever or in commencing catarrh of the nose, and it may often be applied simply by means of a tube, such as I show you, or, what is still simpler, it may be snuffed up into the nose either from a small spoon or from a little bit of paper.

For the application of various liquids to the throat we have bent brushes, so that when the brush is wet one is able to get it right down into the larynx and swab it out. Long ago, before the laryngoscope came into general use, one was accustomed to treat laryngeal phthisis with little sponges tied to the end of a piece of whalebone or of wire, bent into the form I show you. This was simply put into the pharynx, and when the patient took a deep breath you passed it right into the larynx. That it did get into the larynx you could have no doubt whatever, because sometimes you could see the sponge projecting under the thyroid cartilage, and you could feel that the sponge on its return was caught by the vocal cords. Occasionally it becomes necessary to use a caustic to the larynx and then, instead of a sponge, you have an instrument such as I show you, where there is a little point which can be withdrawn or projected at the will of the operator. Into this point a little nitrate of silver is fused, and the point being withdrawn within the holder, you proceed, with the aid of the laryngoscope, to find the exact point of the larynx you wish to cauterise. The caustic-holder is then carefully introduced into the larynx. When its end is just over the spot you wish to cauterise, you project the nitrate of silver point by pressure with the forefinger, and bring it down on the spot.

Sprays.—For application to the throat and to the nose we have also certain sprays. I show you one of the common ones, in which you simply produce a spray which is driven into the nose or into the throat. In speaking of hay fever, I told you that sometimes the application of an ointment, such as the ointment of zinc, to the nose was a satisfactory remedy, and it is very often found that people would like to grease the inside of their throats, if they only knew how. It can be done quite comfortably in this way. You take a liquid, not too greasy to pass through a spray apparatus, and you apply this to the throat. When I say "grease," I am using the term in a very loose way, because ordinary people, who know nothing about chemistry, would call vaseline a grease, in the same way they would lard. Of course they are quite different in their chemical characters, but in regard to their physical properties they may both be looked upon, and are looked upon by patients, as grease. We have no liquid oils that can be used conveniently for a spray, but we have liquid vaselines. One of the commonest of these is known by the name of paroleine, and this is frequently used in such a spray-producer as I show you here. The paroleine itself, without the addition of any other drug, is a very useful application for soothing the nose, the larynx, and the trachea; but very often we add to it something which will have a stimulating and antiseptic action, and a common mixture is a 3 per cent. solution of menthol in pareoline. You may begin with a weaker solution, but the average strength, one may say, is 3 per cent., and it may be increased if the patient stands it. This is most useful in cases of catarrh, either in the throat or nose. The apparatus I show you is made specially for the nose. There is another one made with a long tube, by which you can send the spray right down the throat, or into the posterior nares. The one with the long tube does not answer so well, as a rule, because it is always getting out of order. When patients get the long one, they often come back and say it does not answer, and there is constant botheration. I myself have given up the long tube and stick to the short one, which does not get out of order.

Nasal Douche.—Sometimes in cases of cold or of chronic catarrh, with the formation of scabs, you may wish to wash the nose out, and this you do by means of the nasal douche. Here also you should remember what I told you before: that a normal salt solution is not nearly so irritating to delicate mucous membranes as pure water. The nasal douche is a very simple apparatus. It consists of a long indiarubber tube with a little metal weight at one end, so as to prevent it slipping out of the vessel from which it sucks water, a small, bent metal tube to go over the edge of the vessel to prevent the india-rubber tube from kinking, and at the proximal end you have a somewhat conical nozzle, which, from its shape, completely occludes the nostril. You fill the tube by simply sucking up the water, and then, by raising the supply vessel, you convert your tube into a syphon. When the water is flowing freely, you put the nozzle into one nostril, and make the patient hold his head over a basin with his mouth open, when the fluid will pass up one nostril and out of the other, washing the whole of the nose thoroughly out. One great point to be remembered, however, is that you must not put your reservoir too high up, because you do not want any great pressure inside the nose; otherwise the fluid may make its way through the Eustachian tube, and sometimes give rise to inflammation, both in the tube itself and in the middle ear. This precaution is always to be observed: do not put on too great pressure when you are washing out the nose.

Nebulisers.—Another inhaler that is very useful indeed is the one which is known as a nebuliser, and the advantage it has is that it gives a finer spray than any other kind of inhaler I know. You may adapt to it either a mask, which is placed over the patient's face, or a simple tube to go into the mouth, or a conical tube to go into the nose; and so you can apply the spray either to the nose, the throat, or the lungs. The spray is so fine that sometimes you can hardly see it. A little while ago I prescribed inhalation from a nebuliser to a patient who came back two days afterwards to me and said that the apparatus did not work at all. The spray was so fine that she had not seen it, and thought there was nothing coming, until I put a black book up behind it and showed that there was a considerable amount of spray. This apparatus is really one of the most useful that I know, and I have seen exceedingly good results from its use. In cases of phthisis, by using a creosote spray, I have seen the mucus dry up in a way I certainly did not expect. Along with the apparatus there are a good many formulæ given for cocaine, menthol, camphor, and so on; and it has been recommended in all kinds of diseases of the respiratory organs.

Stomach Cough.—You will often hear patients complain of what is termed a "stomach cough," and for a long time I was inclined to think this was humbug, but I have no doubt that there is a real basis for the term "stomach cough," and it depends upon a fact that I mentioned to you before, viz., that the summation of stimuli brings about a result which a single stimulus would not give alone. You will notice a good many cases of cough where you find nothing in the lungs, but a good deal of irritation in the pharynx and sometimes also in the larynx. During the greater part of the day these people will be free from cough, but not unfrequently after meals they begin to cough; and they cough most violently, and very likely they cough until they are sick. The cough is so severe that, as the Americans say, they look as though they were going to "cough up their immortal souls," and in some cases you really think they are going to die in the paroxysm. The summation of irritation here is due to simultaneous irritation of the larynx or pharynx and of the gastric branches of the vagus. Irritation of the gastric nerves, as a rule, tends to give rise to vomiting, and not to coughing, but the irritation in these cases, though insufficient in itself to produce vomiting, becomes summated with the irritation in the larynx, and gives rise to very violent coughing, perhaps ending in vomiting. One of the best applications that I know in such cases is bicarbonate of soda in large doses. You put half a teaspoonful or a teaspoonful of bicarbonate of soda into half a tumbler of water, and let the patient sip this until the whole of it is gone or until the cough stops. I remember once being called up in the middle of the night to go down to the Old Kent Road. I was not at all anxious to go, because it was an uncomfortable night. When I got there, I found an old gentleman who was not merely red, but purple, in the face. His mouth was open, his tongue was protruding, and he was sitting there almost unconscious, cough, cough, coughing, and he was quite unable to stop. His tongue protruded in the same way that it is said, in books on forensic medicine, to protrude when a man is strangled or hanged. The doctor was very anxious to keep this patient alive, because he was a very good patient; he was seen either once or twice a day, and, having plenty of money, paid the doctor regularly. The doctor thought his patient was going to die that night; he had tried everything he could think of, all the respiratory sedatives he could find in his memory or in his books, but they all failed. I got some bicarbonate of soda and gave it in the way I have just told you. Before I left the old gentleman had stopped coughing, and I have heard from the doctor that his patient is still alive, and has continued to sip bicarbonate of soda for about four or five years, to the great satisfaction both of his doctor and himself.

Respiratory Stimulants.—In cases where the respiration threatens to stop we use what are called respiratory stimulants, and the most powerful respiratory stimulants we possess are carbonate of ammonia and strychnine. There is no stimulant to the respiration nearly so powerful as strychnine. The only two pieces of plate I possess that are worth anything I owe to strychnine, coupled in one case with oxygen. The first case was a very remarkable one, which I have not yet published, but which

I must publish some day. An old gentleman had been getting steadily worse and worse; he was unable to lie down; he was obliged to sit up in bed; he could not lie forward nor to either side. His condition was very distressing. One morning I was called to see him, and was told that this old gentleman had stopped breathing, and that he could not breathe except voluntarily. I thought this must be rubbish, because physiology teaches us that the respiratory centre always lasts longer than the voluntary centres, and it was difficult to conceive of voluntary respiration lasting longer than involuntary. When I went into his room, however, I found that it was so; that the moment he fell asleep he ceased to breathe, and then he awoke with a most awful start. It was quite clear that his respiratory centre had failed, and that he was only able to keep up respiration by voluntary movement. I thought, "Well, he has been getting worse and worse; I have failed to do him any good; I must now smooth the path to death." I filled a syringe with morphine, and was just about to inject it, when it occurred to me that this was not my business, which was to keep him alive if I possibly could. I emptied the syringe of morphine, filled it with a solution of strychnine, stuck the point of the hypodermic syringe into the old gentleman's arm, and injected some. I do not know how much, but I watched him and found that his respiration seemed a little easier. I injected a little more, and then I found, after doing this two or three times, that he fell asleep, his head fell forward upon his chest, and while asleep he continued to breathe. The old gentleman improved steadily from that moment, and lived for a whole year afterwards. I cannot tell you exactly how much strychnine I injected, but it was just enough to make his fingers twitch. I could not have done him much harm if I had poisoned him with the strychnine; at the worst I should only have shortened his life by an hour or so, and I had chloroform ready to smooth the path to death and prevent any discomfort from the strychnine.

Mode of Action of Strychnine.—We often hear that experiments on animals never lead to anything, but all the applications of strychnine are the direct consequences of physiological experiment. Strychnine was first investigated by Magendie, who discovered its action upon the spinal cord. It then continued to be used in cases of paralysis, and it was found that, even when it did not cure the paralysis, it tended to act as a tonic and strengthened people generally. Its action upon the respiratory centre was made out some years ago by P. Rokitansky, or, perhaps I ought to say, by Stricker, in whose laboratory Rokitansky performed his experiments. What he found was that if you divide the spinal cord just below the atlas the animal ceases to breathe, but if you inject a little strychnine beforehand the movements of respiration are not entirely stopped by the section of the cord; and if you give strychnine after the section, respiratory movements will recommence, although imperfectly. This seems to show pretty conclusively that the respiratory centre is not limited entirely to the medulla oblongata, as it is usually supposed to be, but that part of it extends down into the upper part of the spinal cord.

We see, then, that strychnine is a tremendous stimulant to the respiratory centre; and, as a result of these experiments, strychnine has been used as a respiratory stimulant ever since. I do not know exactly how its use has come to be so general in this country. When these experiments were published, Stricker sent me over a copy of the paper, which I abstracted in the "Medical Record." I mentioned it to my old friend Dr. Milner Fothergill, and I lectured upon it here. I may be mistaken, but I think that it was through this agency that Stricker and Rokitansky's experiments have led to such a general use of strychnine as a respiratory stimulant. I was rather astonished to find in a German book on pharmacology and therapeutics the statement that strychnine is of no use at all; that it might just as well be expunged from the Materia Medica. This is very curious, inasmuch as it has been found by comparison with other prescriptions that strychnine, in the form of nux vomica, is more used than any other drug whatever in this country.

Oxygen.—It may sometimes happen that you are unable to keep up the action of the respiratory centre sufficiently, and that you may want to give purer air and more of it. Or it may happen that the amount of lung at the disposal of the patient is not sufficient to aërate his blood, however active the respiration may be. This is a condition that you meet with in bronchitis, and also in pneumonia. In cases of bronchitis, you do not generally succeed in bringing your patient through unless you can clear away the expectoration which clogs the tubes, because if you allow your patient to inhale air, however pure, or to inhale oxygen, the oxygen practically does not get down to the alveoli, and so it is no sort of use. The cases in which oxygen is of very considerable service are, for example, those of diphtheria, where the passages are narrow, and where, if you can get enough pure air in, the child will be very much improved ; or in pneumonia, if one lung only is nearly consolidated, the patient breathes with the other lung, and if you can at each inspiration give him half as much oxygen again as he would ordinarily get, you perceive that it will come to much the same thing as if the affected lung, instead of being completely solidified through its whole extent, were solidified only through half its extent, and you can readily see what an advantage to your patient this would be. But the time when oxygen really comes to be most serviceable is when one lung is clearing up, and the other is beginning to solidify. Then it is a race for life, because if the disease in the second lung spreads more quickly than the first clears up, there will shortly not be enough healthy lung tissue to support life. But, if you can just tide the patient over the short time while the disease is extending in the second lung and is diminishing in the first, and keep him alive until so much of the lung first affected is cleared up that he is able to breathe again, you may thus save his life. There is one remarkable instance of the use of oxygen in this Hospital, and I think I may tell you it is our librarian, because I am certain that he would vouch for the correctness of what I am saying as far as his own knowledge extends. You would hardly believe, I think, that he was for nearly a fortnight almost unconscious ; that he had influenza with an enormous secretion from his lungs, consolidation at both bases, a failing heart, legs which were swelling up, and orthopnœa. His breathing was so exceedingly bad that his blood was not aërated sufficiently to keep his brain going, and he was in a condition almost of stupor for very nearly a fortnight. I believe that if the Hospital had not supplied him with unlimited oxygen, he would never have got well at all. Cylinder after cylinder was sent down to his house, and he inhaled it for ten minutes at a time, as often as his nails got blue.

Administration of Oxygen.—The indications for the administration of oxygen are to watch either the lobes of the ears, the lips, or the nails, and as soon as any of them get blue the patient ought to have some oxygen. You direct the nurse to give it whenever the blueness appears, and to let the patient inhale it until the blueness disappears. Oxygen is sometimes administered by means of a mask placed over the face, but, as a rule, patients do not like a mask: it gives them a feeling that they are going to be choked. The simplest way is, I think, either just to put an ordinary tube into the mouth and let it lie there, or else to attach a funnel to the tube leading from the cylinder, and to let this hang or lie close to the patient's face. In one case where the conditions obtained that I have mentioned, viz., where, one lung being *hors de combat*, the other became bad, the patient recovered, and, I believe, she would not have done so without the plan adopted, viz., simply suspending a funnel over the face about a couple of inches above the nose, so that the oxygen kept flowing in one continuous stream over the face, and was thus inhaled.

There has been a good deal of difficulty about the transmission of oxygen by rail, because the cylinders are not now allowed as passengers' luggage, owing to the fact that one of them exploded at Fenchurch Street Station, and a boy was completely blown up by it. A committee of the Royal Society has been investigating the subject, and it has found that if the oxygen is pure it will not explode, and that the explosion which took place at the station was almost certainly due to the cylinder having been used first of all for coal gas which had not been completely extracted, and afterwards used for oxygen. There was, therefore, really an explosive mixture of coal gas and oxygen in the cylinder. They further found that the cylinder was badly annealed. If the cylinders are well made, they may be smashed in almost any way without exploding. A properly annealed cylinder, if subjected to sufficient violence to burst it, will show a linear rent; it will not break into pieces. Further some cylinders, if filled with pure oxygen and well annealed, may be bent and twisted in almost any direction you like, and they will not break.

In using oxygen you must be careful not to turn it on too violently, because you are very apt to alarm your patient and his friends. In demonstrating the method, you will notice that I take the indiarubber tube off the cylinder before turning the stopcock or allowing the gas to issue. If I did not do so, it is very probable that the funnel would be blown out, as the stop-cock is often stiff at first, and one has to use so much force in turning it that one is apt to turn it too far. Care must be taken that there are no kinks in the tube, otherwise the piece of indiarubber will be blown right off the cylinder by the oxygen. To avoid any risk, you sometimes have a large bag put between the funnel and the cylinder, but the chief use of it is to prevent any sudden risk of blowing up, and this is not likely to occur if a little care be exercised. The amount of oxygen that you allow to stream out is generally regulated partly by the whizzing sound, which should be very faint, and partly by holding the funnel before your own face, so as to see whether there is sufficient gas issuing. In showing you this, I have allowed the oxygen to come out too freely, and you will hear what an unpleasant sound is caused by the tube and funnel being blown off the cylinder. These noises give rise to a great deal of alarm in a sick-room, because the patient or his friends think that the whole thing is going to blow up, but a little care will completely obviate any contingency of the kind.

I daresay it has occurred to many of you that it would be advantageous if one could keep up artificial respiration with oxygen. I have never had an opportunity of trying it, but I have devised an apparatus by which this can be done very easily indeed. You can see that by connecting nasal nozzles to the oxygen cylinder oxygen may be driven through the nostrils into the lungs so as to act like a forcible inspiration, and if you have a means of cutting off oxygen at will, the expiratory movement will be produced by the elastic contraction of the chest-walls;

so that all one has to do is simply to have a stopcock which at one time makes the oxygen cylinder communicate directly with the cavity of the chest, and at another shuts this off from the chest, at the same time allowing free communication with the external air. You observe that when I hold the cock in one position the oxygen is issuing from the cylinder, and would pass through the nasal nozzles into the lungs of the patient. You can see that this is the case by placing the tube in a vessel containing water. At one time the oxygen passes from the cylinder through the nozzles into the lungs, and then, again, with the stopcock in a different position, the oxygen returns from the lungs to the external atmosphere. In this way artificial respiration might be kept up with almost no trouble for a great length of time.

Respiratory Sedatives.—We have now to consider the action of respiratory sedatives. We have discussed this, in so far as local sedatives are concerned, when dealing with inhalation and when dealing with the application of special remedies to the larynx. We have general sedatives which tend to lessen the sensibility of the respiratory centre, and thus render it less liable to respond to the reflex stimuli which cause cough. There are various respiratory sedatives, but the most powerful of them all is certainly opium or morphine in one form or another. We generally use opium or morphine, combined with various other substances, for the purpose of lessening cough, and I daresay you have noticed in passing up Giltspur Street, on your way to the Hospital, an advertisement of "balsam of aniseed," a substance which has an enormous sale as a remedy for cough. Now, the old meaning of "balsam" was a salve for a wound, and the salve generally contained benzoic acid. You can see that this balsam of aniseed indicates by its name that it contains aniseed in some form and contains a balsam of some sort. I do not know the composition of "balsam of aniseed," but there is in the British Pharmacopœia a preparation that might very well bear that name, and which is very useful indeed as a remedy for cough. This is the compound tincture of camphor, ordinarily known as paregoric. It contains benzoic acid—so it may be reckoned as a balsam; oil of aniseed—so it may be called balsam of aniseed.

It also contains camphor, as its name implies, and then—and this is the most important constituent of all—a certain amount of opium. The amount of opium in it is 2 grains in the fluid ounce, or 1 in 240, or $\frac{1}{4}$ of a grain in 1 fluid drachm. In doses of from 20—30 minims it is most useful as a respiratory sedative. I mentioned before that we have in the Hospital Pharmacopœia a "linctus scillæ opiatus," containing compound tincture of camphor, oxymel of squills, and syrup of tolu. The ordinary dose of this is 1 teaspoonful, that is to say, 1 fluid drachm. Another very useful preparation of opium is the compound ipecacuanha powder, the so-called "Dover's powder," and this is used in the form of a certain pill which is one of the most useful cough pills we have: the pilula ipecacuanhæ cum scillâ, containing compound powder of ipecacuanha, squills, ammoniacum, and treacle. Five or 10 grains of the pill of ipecacuanha and squill, given at night or in the morning, is one of the most useful remedies that we have in chronic bronchitis. Another cough pill is the pilula conii composita. This contains no opium; its sedative principle is extract of hemlock, or conium, which is supposed to have a similar action to that of opium upon the respiratory centre. It contains also ipecacuanha, ammoniacum, and treacle.

There is one other mode of treatment which is exceedingly useful in cases of chronic cough or cold, and that is counter-irritation over the chest.

LECTURE 15.

Action of drugs on respiration, *continued*—Counter-irritation—Nervous diseases of respiration—Relation of asthma to gout—Action of drugs on the circulation—Effect of temperature on the heart—Blood pressure—Importance of vascular area of the muscles—Fainting and shock—Regulation of blood pressure—Cardiac disease—Symptoms in mitral regurgitation—Rest and massage—Cardiac tonics—Digitalis.

Gentlemen,

In the last lecture we were discussing the action of drugs upon the respiration, and at the end of the hour I told you that there was one class of remedies especially useful in cases of chronic bronchial catarrh, viz., counter-irritants applied to the surface of the chest.

Counter-irritation.—It is not merely, however, in chronic conditions that we find counter-irritants useful. We find great benefit also from their application to the chest in cases of acute disease: pleurisy, pneumonia, or acute bronchitis. The irritants that we use in cases of acute disease are usually either mustard leaves, mustard poultices, or blisters, and one of the commonest ways of lessening pain in cases of pleurisy is to apply a blister to the chest just over the seat of pain.

In chronic diseases, such as chronic bronchitis, we frequently apply stimulating liniments in place of blisters, mustard leaves, or poultices, which require frequent renewal. One of the most agreeable to use is simply chloroform poured on a piece of lint and covered with oiled silk. In about two minutes after its application a rather severe burning pain is felt over the skin, and at the same time relief is experienced to the pain inside the chest, whether it be due to pleurisy or to acute bronchitis. The other liniments that one frequently employs are the linimentum terebinthinæ aceticum and the linimentum camphoræ compositum. Both are powerful stimulants; and here I may say a word about incompatibility. There are certain drugs which do not go very well with one another, and these two liniments which I have just mentioned are good examples of incompatibility. Either the one or the other forms a powerful stimulant to the skin, but if you mix them together they have no action, the reason being that the activity of the acetic turpentine liniment depends upon the acetic acid it contains; the activity of the compound camphor liniment depends upon the free ammonia present in it. So that if the acetic turpentine liniment and the compound camphor liniment be mixed together the acetic acid neutralises the ammonia, and you get acetate of ammonia formed, and this has no local action at all. An old-fashioned remedy was the application of tartar emetic ointment, which was rubbed in over the chest, and this was used to a very great extent in cases of phthisis. It brought out a crop of pustules. This ointment has fallen into almost complete disuse, but pustulation of the chest in a case of chronic bronchitis is sometimes very efficacious indeed, and a good way of producing it is by applying the emplastrum calefaciens, or warm plaster (B. P.). This plaster, placed over the chest in such cases, frequently gives very great relief indeed, and the cases of chronic bronchitis and winter cough which occur, not by the dozen or by the score, but by the hundred, in the out-patient practice of this Hospital, are often best treated by the application to the chest of the linimentum terebinthinæ aceticum or the emplastrum calefaciens, by some linctus simply to relieve the cough, and by 5 or 10 grains of ipecacuanha and squill pill every night, or even night and morning, to give some sleep, as well as to lessen the bronchial irritation.

Further in these cases you will find a drug which does not come under the ordinary head of expectorants to be of the greatest service, viz., cod-liver oil. The general verdict of patients suffering from chronic bronchitis is in favour of cod-liver oil rather than of any cough mixture whatever; some of them go on month after month during the winter taking cod-liver oil, to their own great benefit as they themselves assert. The antimonial ointment formerly largely used as a counter-irritant has of late years fallen largely into disuse. In place of it iodine is now largely employed in phthisis, either in the form of the liniment, of the liquor, or of the tincture. Sometimes the ointment is used, but not very frequently. Iodine is generally used wherever you have got any consolidation due either to pleurisy or commencing phthisis. The rule is to paint some solution of iodine over the consolidated patch as often as the skin will stand it, but this must not be done too frequently or too strongly, for otherwise you get a large blister forming, and the patient's skin becomes so tender that he is unable to bear the application of the drug for a good while afterwards. You generally begin, if you have a large surface to cover, by painting about a fourth of it; the remaining fourths are each painted over in succession, and by the time you have reached the last fourth you are almost ready to begin at the first again.

Nervous Diseases of Respiration.—Another class of respiratory diseases is formed by those cases in which the malady depends not upon any organic change in the respiratory passages, but upon some disturbance of the nervous system, as, for instance, in spasmodic asthma. In this condition you find that the patient is apparently well at one time, and that in half an hour or less the utmost distress of breathing may come on; this may be so marked that he is unable to lie down at all. After this distress has continued for several hours the patient again suddenly becomes well. Now, spasmodic asthma may come on in a person whose chest is, to all appearances, perfectly healthy, but it may come on also in a person suffering from bronchitis or emphysema. Even in cases where the patient is apparently healthy there is often some reflex irritation in some part of the respiratory passages, the nose, trachea, bronchi, or lungs, which leads to the spasm coming on.

I mentioned to you before that reflex irritation from the nose is a very common cause of hay fever, and that this may often be prevented by smearing the inside of the nose with a thick ointment, such as zinc ointment, or by rendering the nasal mucous membrane less sensitive by the local application of cocaine. The same remedies that are useful in hay fever are useful in hay asthma, and you will very frequently find that when one member of a family suffers from hay fever another suffers from spasmodic asthma. But you will notice also that you may sometimes get skin eruptions, or liability to urticaria or to eczema, in some members of a family in which others suffer from hay fever or hay asthma. All these four affections, (1) spasmodic asthma or hay asthma, whether dependent upon hay or not, (2) hay fever, (3) eczema, and (4) urticaria, may be, and often are, different manifestations of the gouty diathesis, and it is often the best plan to treat the gouty condition rather than its local manifestation. By sending such patients to the various watering-places useful in gout, such as Hombourg, Aix, or Harrogate, the gouty condition is lessened, and the asthma clears away of itself. We also use such remedies for asthma as are useful in gout generally. For example, arsenic is a favourite remedy both in gout and in asthma. Alkalies and iodide of potassium are also employed extensively in these cases to lessen the spasm. It has been found that the inhalation of various smokes is most useful. The commonest and cheapest is the smoke that rises from a piece of blotting-paper that has been dipped in a solution of nitrate of potash and then dried. Occasionally the addition of a little chlorate of potash to the nitrate in which the paper has been soaked seems to render the smoke that arises from it when burning more efficacious. But perhaps the best remedies are those which contain the dried leaves of some of the Atropaceæ, either belladonna, datura stramonium, datura tatula, or some other species of datura. The smoke arising from these dried leaves seems to give great relief to the patient, lessening the spasm, and allowing him to breathe freely; but these leaves would not burn if they were simply powdered, and so, as a rule, a small quantity of nitrate of potash is added.

There are various secret remedies which are used extensively for the treatment of asthma. One of these, which is taken internally, contains, as I know from analysis, a large quantity of iodide of potassium, and it probably contains a number of other drugs besides. Another remedy that we use internally is tincture of lobelia in doses of 10, 15, or 20 minims. Iodide of potassium, tincture of lobelia, and bromide of potassium, with arsenic, are probably the remedies that are most used internally in cases of asthma. The powders that are used probably nearly all have as their basis the leaves of various species of datura mixed with a certain quantity of nitrate of potash.

Action of Drugs on the Circulation.—We may turn now from the consideration of the respiration to that of the circulation. You know that the first thing, or almost the first thing, that a doctor used to do was to feel the pulse, and before the introduction of the stethoscope or of the thermometer the pulse was still more important in the diagnosis of disease and in the estimation of the condition of the patient than it is now, because (1) from the rate of the pulse the doctor was, to a certain extent, able to judge of the temperature of the patient, whether he was feverish or not, (2) from the strength of the pulse he judged of the general strength of the patient, and (3) from the nature of the pulse he frequently could come to a very shrewd diagnosis regarding the nature of the disease. Now the reason why he was able to judge of the temperature of the patient from the rate was simply this: that the pulse rate depends to a great extent upon the temperature at which the heart is working, and a rise of temperature will quicken the beats of the heart quite independently of any action of the central nervous system, while lowering of the temperature will slow the beats of the heart, as can be well shown by the effect of heat and cold upon the heart of a frog.

Effect of Temperature on the Heart.—A frog is killed, the heart removed and placed upon either a piece of tin or a piece of glass, and over the heart is fixed a light lever, by which the movements of the heart can be made visible at a distance. You will see here the heart of a frog is placed under the lever, but you will observe that it is moving very slightly indeed; the beats are very feeble, and this is perhaps as instructive a thing as I could show you. The reason of this is that the hearts of frogs die very quickly after removal from the body in hot weather. In winter, however, there is much less difficulty in showing the experiment, because the excised heart lasts much longer, and beats forcibly for half an hour or even an hour, whereas, in the preparation before you, you will observe that

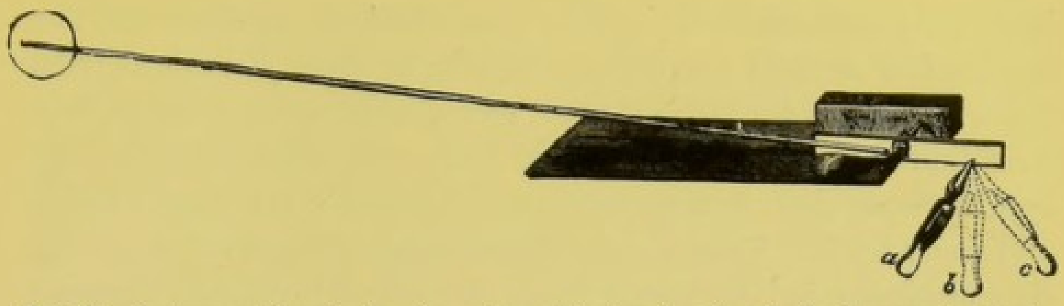


FIG. 88.—Instrument for showing the action of heat and cold and of poisons on the frog's heart. It consists of a piece of tin plate or glass three or four inches long and two or three wide, at one end of which an ordinary cork cut square is fastened with sealing-wax in such a manner that it projects half an inch or more beyond the edge of the plate. This serves as a support to a little wooden lever about three inches long, a quarter of an inch broad, and one-eighth of an inch thick. A pin is passed through a hole in the centre of this lever, and runs into the cork, so that the lever swings freely about upon it as on a pivot. The easiest way of making a hole of the proper size is simply to heat the pin red-hot, and then to burn a hole in the lever with it. To prevent the lever from sliding along the pin, a minute piece of cardboard is put at each side of it, and oiled to prevent friction. A long, fine bonnet-straw, or section of one, is then fastened by sealing-wax to one end of the lever, and to the other end of the straw a round piece of white paper, cut to the size of a shilling or half-crown, according to convenience, is also fixed by a drop of sealing-wax. The pin, which acts as a pivot, should be just sufficiently beyond the edge of the plate to allow the lever to move freely, and the lever itself should lie flat upon the plate. Its weight, too, increased as it is by the straw and paper flag, would now be too great for the heart to lift, and so it must be counterpoised. This is readily done by clasping a pair of bulldog forceps on the other end. By altering the position of the forceps the weight of the lever can be regulated with great nicety. If the forceps are drawn back as at *c*, the flag is more than counterbalanced, and does not rest on the heart at all, while the position *a* brings the centre of gravity of the forceps in front of the pivot, and increases the pressure of the lever on the heart. The isolated frog's heart is laid under the lever near the pivot, and as it beats the lever oscillates upwards and downwards. When used for demonstrating the action of poisons the wooden lever should be covered with sealing-wax, so as to allow every particle of the poison to be washed off it, and thus prevent any portion from being left behind and interfering with a future experiment. By attaching a small point to the end of the straw in place of the paper flag, tracings may be taken upon smoked paper fixed on a revolving cylinder.

the beats of the heart are very feeble indeed. As we warm it we shall probably find that it will go more quickly and more strongly, and then as the temperature still further rises it will stop altogether. We will now put underneath it a piece of ice, and usually we find the phenomena reversed; viz., the heart begins to beat again rapidly at first, afterwards more and more slowly, until at last it ceases almost entirely. Supposing that, at the normal temperature, the heart is beating at a rate which might be represented by | | | |. On application of heat it would tend to go much more quickly at first | | | | | |, then very much more feebly, until at last it stands still in a condition of systole. This condition of systole is known as heat tetanus, and the heart may recover if it be cooled down in time, but if the temperature be raised a little higher the heart falls into a condition of what is known as heat rigor, from which it is impossible to recover. If, however, the temperature has been only sufficiently raised to produce heat tetanus, on the application of cold the reverse occurs, so that you get at once the quick beat, becoming larger and slower until it stops in a condition of diastole. The effect of heat, then, when continuously applied, is, as you have already seen, to render the heart feeble and ready to die. This is a condition which occurs from external circumstances in the frog's heart in our experiment, because in summer the external temperature is high, but it occurs also in our fever patients on account of the high temperature of the interior of the body. As the temperature rises in fever, so you get the pulse becoming quicker and quicker, feebler and feebler, until the heart ceases to beat entirely; and just as you can recover the frog's heart from the effect of high temperature, so you can, in many cases, recover the hearts of your patients from the effect of high temperature by cooling them down. This is one of the great advances that have been made of recent years in the treatment of high fever. By cooling the patient down you cool the blood, and thus allow the circulation to go on again.

You here see that the heart can beat quite well when separated from the body, but if I were to put a tube into the aorta of the frog from which this heart has been removed, and connect the tube with a reservoir containing either saline solution or serum, the circulation would still go on in the tissues of the frog's body, although the heart had been removed. The heart, then, is not essential to circulation through the tissues. Of course, when the heart stops, the circulation soon ceases, but it does not cease at once, and the circulation throughout the tissues is not kept up directly by the heart for more than, let us say, six or eight hours out of every twenty-four, because the systole of the heart does not amount to more than one-fourth or one-third of the total period of the heart's revolution, and so during the diastole the circulation is kept up entirely apart from the heart. During the diastole of the heart, which takes up sixteen hours out of the twenty-four, the circulation is kept up in the tissues, not by the heart, but by the tension of the blood inside the arteries.

Blood Pressure.—Now, the tension of the blood inside the arteries simply depends upon the fact that blood is being pumped into them as quickly as it passes out, and that it has at some previous time been pumped into them more quickly than it could pass out. It is easy to represent the tension of the blood in the arteries, or, as it is usually termed, the blood pressure, by a very simple schema. We have got here the ball of an ordinary spray-producer to represent the heart, while the elastic bag, covered with netting, represents the aorta and arteries, and a large indiarubber bag represents the venous system. The spray-producer is connected with a mercurial manometer, and the passage of air into the venous bag is regulated by a stopcock. If I work the ball, you will see that at each squeeze the mercury is driven up and in the tube, and that it oscillates up and down, the oscillation being one of the troubles in making an exact estimate of blood pressure (Fig. 89).

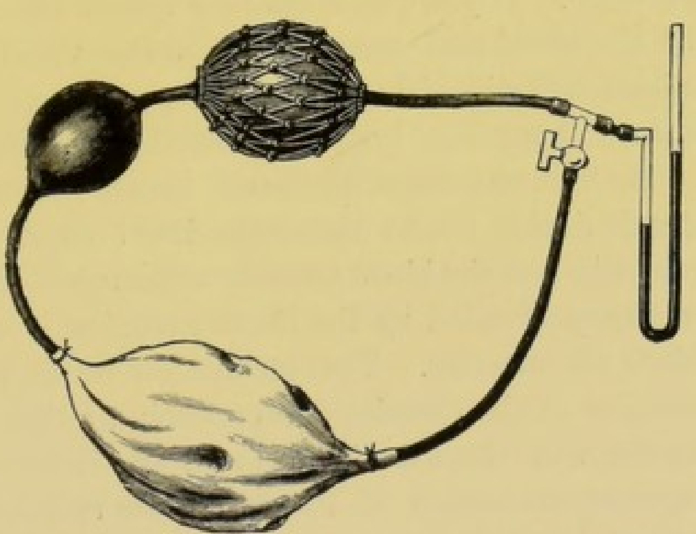


FIG. 89.—Simple scheme of the circulation, consisting of a spray-producer, bladder, and mercurial manometer. The elastic ball represents the heart; the elastic bag, covered with netting to prevent too great distension, represents the aorta and arterial system; and the bladder represents the venous system.

When I begin to work the ball the little elastic bag covered with netting—the arterial bag, as we may call it—becomes more and more tense, and the mercury rises to a corresponding height. I now allow a little of the air to pass into the venous bag, and you see that the arterial pressure falls, and falls at a rate corresponding to the rate at which the air can pass out from the arterial into the venous bag. When I begin to work the ball again, you see that the pressure rises, but that the mercury oscillates with every beat of the heart, *i.e.*, every squeeze of the indiarubber ball. Now, we can regulate the tension in the vessels in two ways: either (1) by sending blood in more rapidly by the heart, or (2) by letting it out more slowly through the arterioles into the venous system. The venous system is so large that, when it is completely relaxed, it will hold all the blood in the body, as it does after death. The only difference between letting blood into the venous system and into a vessel outside the body is that the blood gets very readily back from the venous system into the arteries; whereas, when it is let out of the body, it is very difficult to get it back into the arteries. But if we allow the whole of the blood to flow from the arteries into the veins, the man or the animal will die, and it is, indeed, possible to bleed an animal or a man into his own veins. If you put a ligature round the vena cava, the whole of the blood will accumulate in the venous system, and the animal will die, although not a particle of blood has been withdrawn from the body; it dies by bleeding into its own veins. If the heart stops, the same result will take place. The blood tends during life to distribute itself as it does after death, viz., the whole of the blood tends to accumulate in the veins. This is, however, prevented by the heart pumping it out of the veins back into the arteries. The feebler the heart, the nearer will the condition of the circulation approach to that of death; viz., the emptier will the arteries be, and the fuller the veins: the more vigorous the action of the heart, the emptier will the veins be, and the fuller the arteries. As we take the blood pressure in the arteries, we may say that, speaking generally, the more active the circulation the higher will be the arterial tension. This is, however, only true within certain limits; the higher the tension, the greater is the potential power of circulation, but the ratio between the arterial tension and the actual circulation is not quite so simple. The higher the tension in the main pipe in a street, the greater the power of possible supply of water to a house, but if the taps leading to that house be shut, there may be really a less supply of water to the house than if the pressure in the mains were lower. And the same is the case with the body, because the circulation of blood in the body may be very fairly compared to the circulation of water in a large city. We have in the large mains a high pressure, and this can be let on to various districts according to the requirements of the district. The turncocks in the body are the vasomotor nerves, which allow the vessels to dilate or contract according to the requirements of the tissues. Now, when the pressure in the arteries falls very low, we have a tendency to general failure of the circulation, and this may lead to what is known as fainting or syncope, in which condition the surface becomes cold, and the patient blanched and unconscious.

In considering the pathology of this condition, we have to remember that there are three large channels through which the blood finds its way from the arteries into the veins, and it is rather curious to see that, even in the best books on physiology, very little is said about more than two channels. You will notice, if you look up your books on physiology, that a great deal is said about the vessels of the skin and the vessels of the intestine, but very little is said about the vessels of the muscles. Yet the vessels of the muscles are so large that they will allow as much blood to pass through them in a given time as both the vessels of the skin and the vessels of the intestines together. I show you a diagram (Fig. 90). The blood flows from the aorta into the veins, through the vessels of the skin, of the muscles, and of the intestine. These have, to a certain extent, a compensatory action. When less is flowing through the skin, more flows through the vessels of the intestine, and *vice versâ*. But if you shut up both the vessels of the skin and those of the intestine, the blood will often flow through the vessels of the muscles almost as quickly as it did before. The way of estimating the flow is this: you stop the heart, and you find that the blood pressure suddenly sinks. One would say that, if you contract the vessels of the skin and the vessels of the intestine by irritation of the vasomotor centre in the medulla, the blood would be prevented from passing so quickly out of the aorta, and thus the blood pressure, as measured in one of the great systemic arteries, would sink much less rapidly. This, however, is not the case. In fact, the rate of fall is almost the same

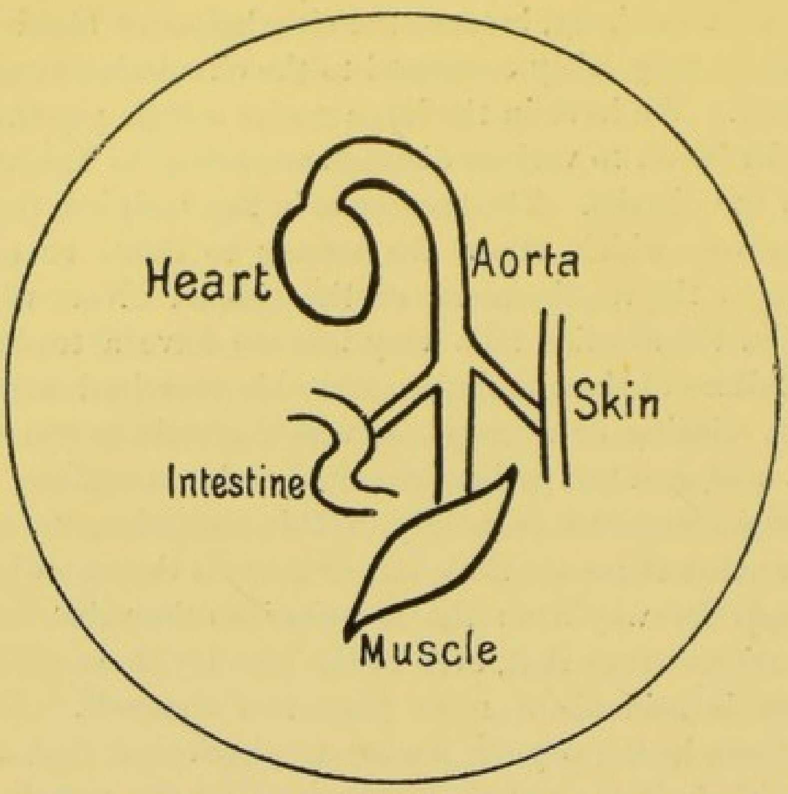


FIG. 90.—Diagram showing the three great areas for the distribution of blood in the body, viz., the muscles, the intestine, and the skin.

as if the vasomotor centres had not been irritated. This shows that when the heart is stopped, and when the vasomotor centres governing the vessels of the skin and intestine are irritated so as to cause contraction of the vessels of these areas, the blood still rushes through the vessels of the muscles.

Fainting and Shock.—Now, in fainting it would appear that the vessels of the muscles dilate, because the skin gets very pale, and the patient becomes apparently almost pulseless. John Hunter was one day bleeding a patient, and just at the moment when she fainted he noticed that the blood which was issuing from the vein at the bend of the elbow, instead of being dark, as before, became of a bright red colour, just like the blood that passes from the vein in the sub-maxillary gland when the chorda tympani is irritated. Now, this redness of the blood was almost certainly due to dilatation of some vessels. It could not be the vessels of the skin, because they were contracted, and the skin was pale. The seat of dilatation was therefore in the vessels of the muscles. When the blood is flowing away so quickly through the capillaries, the arterial pressure diminishes, and there is a tendency for less blood to go to the brain. The brain from want of blood may be so anæmic as to lose its

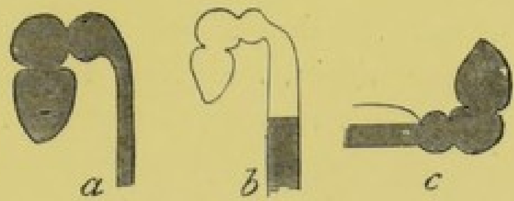


FIG. 91.—Diagram to illustrate the effects of the horizontal and vertical positions on the circulation of the frog in shock. *a*, normal circulation in the upright position. *b*, circulation after dilatation of the veins has been produced by a blow on the intestines. The blood does not reach the heart, and it beats empty, so that the circulation stops. *c* shows the circulation in a horizontal position after the veins have been dilated, as in *b*. The veins are still dilated, but the blood reaches the heart, and the circulation is carried on. Fig. *c* is perhaps too diagrammatic, as it appears to show an empty space in the veins. In reality the veins, being very thin-walled, collapse. Fig. *b* is open to the same objection, but if we suppose ourselves to be looking at the vein from the front instead of in section, *b* represents almost exactly what I have seen myself in repeating Goltz's experiment.

functional activity. This tendency to anæmia of the brain, manifesting itself, as it does, by a feeling of faintness, can to some extent be counteracted, as I mentioned to you in a former lecture, by placing the patient flat on his back, or bending his head down between his knees. In cases of shock the vessels of the intestine are probably more dilated than those of the muscles, and there we get a different condition. The patient is generally perfectly conscious, but hardly able to move, and suffers dreadfully from difficulty of breathing whenever he does move. As I said before when speaking of the brain, we may sometimes induce fainting by raising a person rapidly from the recumbent to the standing posture, and I said also that this occurred more readily when the nerve centres were not acting briskly enough. I also mentioned one or two cases where I had seen it occur. In one the man was half asleep, and in the other the man's nervous system was dulled by opium. The same result occurs in cases where the nerve centres are dulled by anæsthetics.

Regulation of Blood Pressure.—It appears that the fall of blood pressure which would otherwise occur in the vessels of the brain when the upright position is assumed is normally compensated, or even more than compensated, by a contraction of the arterioles so considerable as to counteract, or more than counteract, the effect of gravity, and the blood supply of the brain is kept normal. At the same time we find a compensation occurring between the heart and the vessels, so that when the tension within the vessels becomes great it acts as a stimulus to the vagus roots, and the heart becomes slower. Then the pressure becomes less again, and the slowness of the heart counterbalances the effect of contraction of the vessels. So that the diminution of pulse frequency, produced by the slowing of the heart, keeps the tension down to the normal level, instead of allowing it to be raised up above the normal level by the contraction of the vessels. These phenomena, however, occur only within certain limits; they do not absolutely counterbalance one another.

In health, then, we have one apparatus which regulates the blood pressure through its action on the heart, and we have a second which regulates it through its action on the vessels. The effect of heat upon the heart is to increase its strength as well as its rapidity, and it is well to remember this, because heat is probably the most powerful stimulus that we can apply to the heart in cases of failing circulation. A hot-water bag over the cardiac area frequently tends to make the heart begin to beat again, and we can also apply heat to the heart easily through the stomach; so that a hot-water bag outside the chest and a hot drink inside the stomach both act as powerful stimulants to the heart.

We have two modes of regulating the blood pressure through the heart by means of the vagus. Increase of tension in the blood vessels of the medulla stimulates the vagus roots and slows the heart; diminished tension in the medullary vessels lessens the stimulus to the vagus roots and allows the heart to go more quickly; so that the mere tension in the vessels of the medulla acts as a regulator to the beats of the heart, and thus to the arterial pressure.

Then we have a second apparatus for regulating the blood pressure in the vessels. Whenever the tension in the heart is great, the depressor nerve seems to be excited, and it causes the vessels of the intestines to dilate, but you must remember that excessive tension inside the heart does not dilate the vessels if

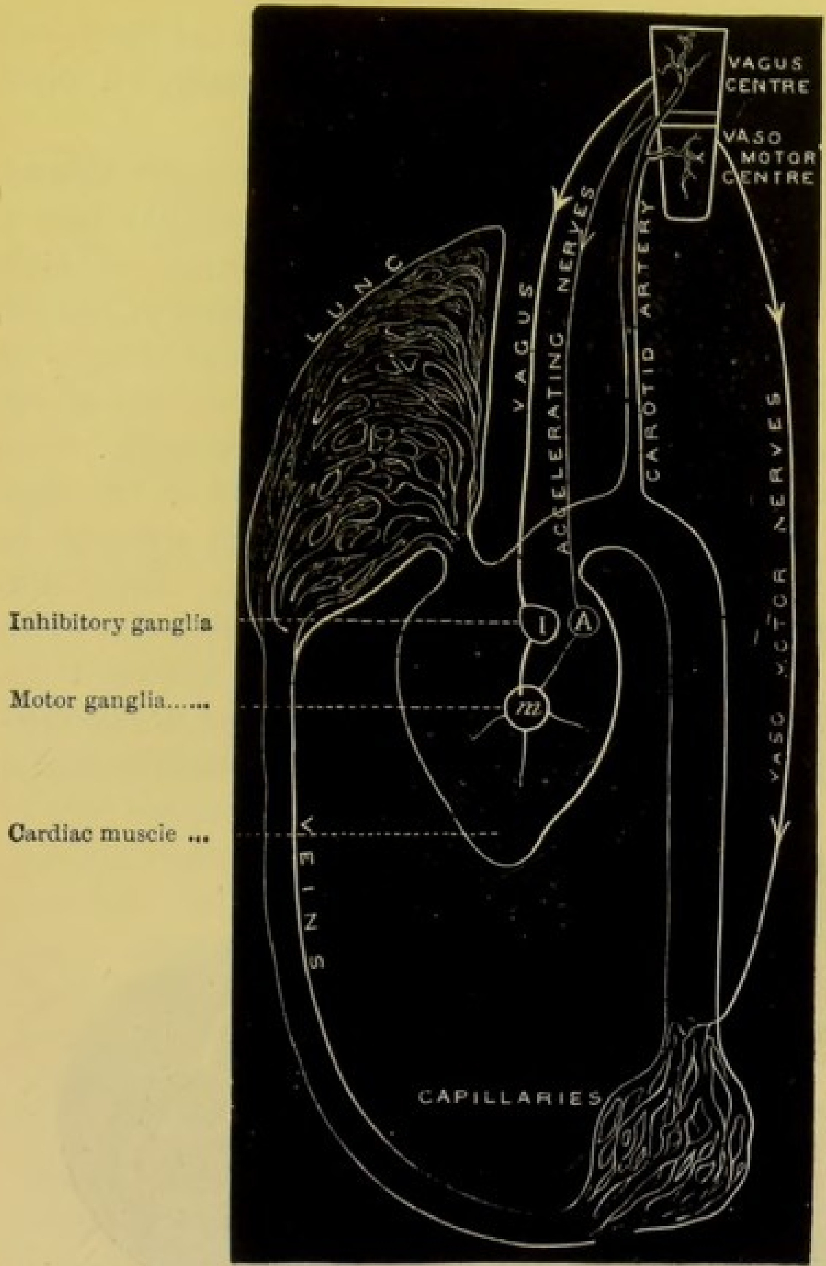


FIG. 92.—Diagram of the heart and vessels to illustrate the action of drugs on the various parts of the circulatory apparatus. A indicates accelerating ganglia.

this apparatus has got out of order. If you cut the vagi and the depressors, and raise the tension in the heart, a great quickening instead of a slowing of the heart occurs, and this is the condition that you occasionally find in disease. It is a condition that may be modified very much by the action of drugs, and if in an animal with the vagi and depressors cut you raise the arterial tension, the pulse rate goes up to about four times its former pace. If you then inject atropine you paralyse the stimulating effect of increased tension upon the heart, and bring it back to the normal. We have in health all these compensatory mechanisms.

Cardiac Disease.—In disease these mechanisms get thrown out of gear, and very frequently the circulation gets into a vicious circle which can only be broken by treatment. This is perhaps more noticeable in the case where the mitral valves get out of order. The mitral valves may be thrown out of order or rendered functionally incompetent without any disease of the valves themselves. This is a condition that occasionally occurs in patients suffering from anæmia, where you get all the signs and some of the symptoms of mitral incompetence, although in all probability the mitral valves are quite healthy. The reason appears to be this: that in the healthy heart the muscular fibres during their contraction tend to close the various orifices of the heart. You see here the cast of a large dog's heart in full contraction (Figs. 93 and 94), and you will notice that the mitral

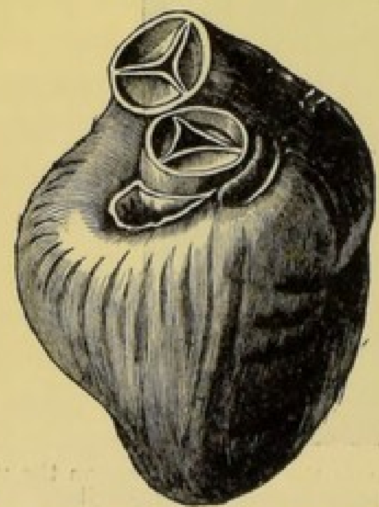


FIG. 93.—Heart in full systole, showing the mitral and tricuspid orifices so diminished by the muscular contraction that the valves close them easily.

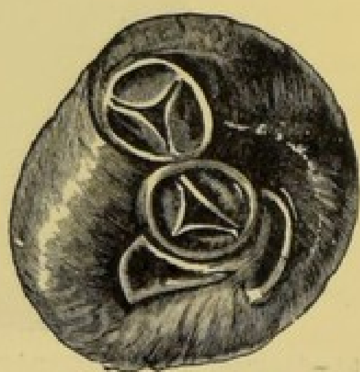


FIG. 94.—The same heart as in Fig. 93 from another point of view.

orifice and the tricuspid orifice are both almost entirely closed by the mere contraction of the muscular fibre of the heart-wall. I also show another cast of a dog's heart in full dilatation (Fig. 95), and you will observe that the two orifices, although the valves are perfectly healthy, are so enlarged that it is hardly possible for the valves completely to close the orifices. This

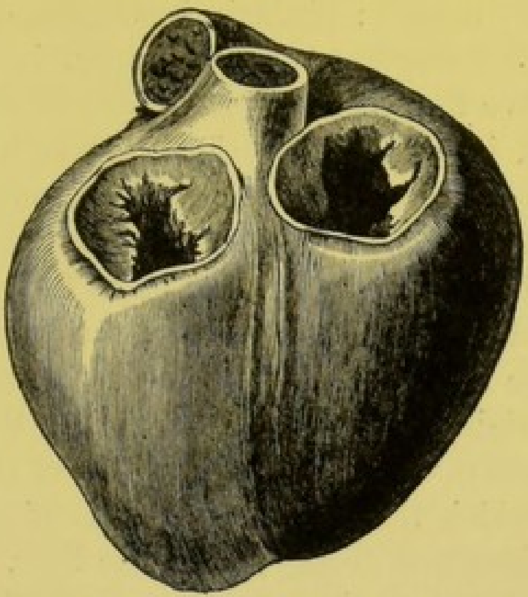


FIG. 95.—Heart fully distended, showing insufficiency of the valves to close the mitral and tricuspid orifices.

appears to be the case in certain conditions of cardiac weakness. You can also readily see that in cases where the valves are partially diseased, and do not completely close the orifice, a still greater regurgitation of blood will occur, if at the same time the muscular fibres of the heart are feeble and do not contract properly, whereas, if the muscular fibres are strong and contract forcibly, the valves, although imperfect and damaged, may be able to close the small orifice so far as to render the regurgitation very slight and of no practical importance. Now, in the healthy body, each time the heart contracts the whole of the blood contained in the ventricle is sent out into the aorta, and passes thence through the vessels of the skin, intestines, and muscles on to the venous system, from which it is again pumped by the right ventricle, and sent through the pulmonary vessels on to the left ventricle again. But in cases where, either from functional weakness of the cardiac muscle or from disease of the mitral valve, the blood, instead of all going into the aorta, to some extent goes backwards into the auricle, we get a very grave train of symptoms indeed; and these symptoms, consequent upon incompetence of the mitral orifice, may come on quite gradually. They may arise also in consequence of disease of the lungs, which tends to interfere with the flow of the blood through them, and so we see them occurring in many cases of severe pulmonary disease: phthisis, bronchitis, or asthma. Let us take in order the symptoms which occur in a case of mitral regurgitation. We find that the blood, instead of going into the aorta, goes back into the left auricle. There it tends to dilate the auricle, to obstruct the flow of blood onwards from the lungs; the lungs become congested; the congestion propagates itself through the pulmonary arteries on to the right side of the heart; the right side becomes dilated; the valves of the right ventricle become incompetent. The blood then flows during the systole of the right ventricle backwards into the right auricle, then into the vena cava, and thus congestion of the whole venous system arises, which tells upon the vessels of the legs, leading in them to swelling and dropsy; upon the liver, causing congestion and enlargement of this organ; upon the kidneys, causing albuminuria; and upon the vessels of the abdomen, leading first of all to distension with flatus, and then afterwards to distension of the abdomen with fluid. Each of these symptoms in turn, as it comes on, tends to increase the mischief, and so the patient goes steadily on from bad to worse, until by means of treatment we are able to bring him round.

Rest and Massage.—Now it is quite clear that the first thing we have to do in such a condition as this is, if possible, to allow the diseased organ to recover itself, and this we do by means of rest. You will frequently find that in cases of almost hopeless cardiac disease you get the patient recovering, and making a most marvellous recovery if you simply keep him quiet. It is very difficult indeed sometimes to keep patients quiet, but occasionally I have found that they see the sense of it if it be explained to them in this way: "If you have sprained your ankle, you know perfectly well that every movement you make is likely to keep up the mischief. What you must do is to go to bed and keep the ankle perfectly quiet. If you have broken your leg, the treatment is the same, and if you have strained your heart or broken a valve, the treatment is just the same. You must give the heart rest, just as you give rest to the ankle or leg, and the consequences of disregard of this are the same in both cases. If you go on walking, with a sprained ankle or broken leg, it will become worse and worse, and finally you will be unable to do anything with it; if you go on exercising with a strained heart or with a broken valve, then you will continue to get worse, and in the end you must either give it rest or die." This very often reconciles patients to the advice that is at first so very disagreeable; viz., to go to bed for several weeks. They see at once that if their leg were broken they would have to go to bed for several weeks, and if their heart is diseased that it is really not such a very bad cure after all, and they very often become willing to go to bed. But they raise the objection, "If we go to bed we get so weak," and this is quite true; people do to a certain extent get weak when lying in bed. But you are able to counteract this by the use of massage, because by massage you tend to keep up the circulation in the skin, in the muscles, and in the abdominal cavity without putting any strain upon the heart, so that you are maintaining the nutrition of the tissues generally and of the heart itself without putting the least strain upon this organ. Therefore by means of rest and massage you are very often able to get the patient round.*

Cardiac Tonics: Digitalis.—But you can readily see that if we have some drug that will tend to increase the contractile power of the heart, it will still further aid us. Now, one drug that has this power is caffeine. It has an action upon involuntary muscular fibre, and also upon voluntary muscular fibre, tending to increase its contractile power; and so it is found to be a useful cardiac tonic. There are certain other drugs which have an action somewhat like that of caffeine in increasing the muscular power, but they act not so much upon the cardiac muscle itself as upon the cardiac nerves, both those contained in the heart itself and in the medulla. The most powerful of these, or at least the one most generally used, is digitalis.

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* For a further discussion on the effects of massage on the circulation, readers are referred to the following papers by the author :—

(1) "On the Use of Rest and Massage in Cardiac Affections." "Practitioner," vol. li, No. 3. (2) "The Harveian Oration." October, 1894. (3) "On Atheroma." "The Lancet," October 12th, 1895. (4) In conjunction with F. W. Tunnicliffe, M.D., "The Effect of the Kneading of Muscles upon the Circulation, Local and General." "Journal of Physiology," vol. xvii, No. 5 (December, 1894).

Digitalis has an action, however, not merely upon the heart, but upon the vessels as well. It increases the muscular contraction of the heart, it slows the pulse, and it causes also contraction of the vessels.

If its action upon the circulation were confined to slowing the heart, the blood pressure, instead of being raised, would be lowered. This depressant action which slowing the heart would have, however, is more than compensated for by the increased force of the cardiac beats and the concomitant contraction of the arterioles. Hence the effect of digitalis in therapeutic doses is not to lower, but to raise, the arterial tension.

The slowness of the heart allows the ventricle to become fuller, and a larger wave of blood is sent into the aorta at each pulsation. By this means we have the veins emptied, and the arteries filled. As the heart beats more slowly, the pulmonary vessels have more time to empty themselves more thoroughly into the left auricle and left ventricle. The more forcible contraction of the muscular fibres tends to lessen the mitral orifice and thus to diminish the quantity of blood which is driven backwards at each systole, or, in other words, to increase that which is driven onwards into the aorta. The lessened pressure in the vessels of lungs diminishes the congestion, dyspnœa, irritation and cough. The lessened pressure in the pulmonary vessels further allows the right ventricle to drive the blood on more easily, and in this way diminishes the pressure in the right auricle, *i.e.*, renders more easy the flow of blood from the vena cava into the right auricle, and thus congestion is lessened in the limbs, in the abdominal cavity, in the kidneys, and in the liver. But we must remember that it is *venous* congestion which is lessened, and that, as there is less blood in the veins, there is more in the arteries. In consequence of this, although congestion is lessened in the veins of the kidneys, the pressure in the renal arteries is higher; more blood is actually driven through the kidneys in a given time; and thus we get the further phenomenon of diuresis, which is one of the most useful effects produced by digitalis.*

* For a further account, historical, critical, and experimental, of the action of digitalis, readers are referred to an article written by the author

LECTURE 16.

Cardiac disease, *continued*—Diuretics—Digitalis—Precautions in using digitalis—Syncope during use of digitalis—Symptoms of digitalis poisoning—Digitalis of doubtful use in advanced fatty degeneration and advanced Bright's disease—Active principles of digitalis—Strophanthus—Convallaria—Nicotine—Smoker's heart—Aconite—Alcohol a circulatory stimulant—Ammonia.

GENTLEMEN,

Last day we were considering the changes in the circulation which occur when the valves of the heart become incompetent, either from actual disease of the valves themselves or from feebleness of the cardiac muscle. I mentioned to you that those changes might be prevented, or indeed recovered from, to a great extent by the use of certain remedies, and more especially by the use of such remedies as increased the power of the cardiac muscle, so that it would contract more forcibly, close the articulo-ventricular orifices more perfectly, and thus bring about to a great extent the normal circulation. I mentioned also that the ordinary changes in the vascular system under such a disease as I have been describing consisted chiefly of empty arteries and full veins, and that the venous fulness acted upon many organs; amongst others, it affected the kidneys, leading to a scanty secretion of urine and the presence of albumin in the urine. As the digitalis, or other drug which stimulates the heart and the vessels, commences to act, and the blood is pumped out of the veins into the arteries, the backward venous pressure on the kidneys, as well as upon other organs, is relieved; the tension in the renal arteries, as well as in other arteries of the body, becomes increased. And so we

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in conjunction with Dr. Tunnicliffe, entitled "The Cause of the Rise of Blood Pressure produced by Digitalis," "Journal of Physiology," vol. xx, p. 354 (October, 1896).

have a disappearance of albumin, on account of diminished venous pressure in the kidneys, and an increase in the secretion of urine, on account of the increased arterial pressure. These drugs, therefore, act secondarily as diuretics.

Diuretics.—A good deal of dispute has arisen as to the action of cardiac tonics in health, and you will find that it is usually stated that in health digitalis does not act as a diuretic. Now this statement is only true with certain limitations. Occasionally these drugs may act as diuretics, and as powerful diuretics, even in health. The reason for this appears to be, that the pressure in the arteries of the kidney under normal conditions varies very greatly in different individuals. I investigated the subject in my own case, and the pressure in my arteries being usually rather low, they responded readily to the action of digitalis, so that, although I was perfectly healthy, the secretion of urine became greatly increased. Other observers, however, equally careful, have not found this increased secretion, and the only reason that I can give for this fact is that probably in their experiments the arterioles were under normal conditions more contracted, that the blood pressure in them was higher, and therefore digitalis acting upon them did not produce the same rise in pressure and the same flow of blood through the renal arteries that it did in me. But, although there is this discrepancy of opinion regarding the diuretic action of digitalis and other cardiac tonics in health, there is none whatever, I think, in regard to their effect in disease. In cases where the urine has become greatly diminished in consequence of low arterial pressure, digitalis and its congeners almost always act as diuretics; but there is a stage in the action of all these drugs in which they do not act as diuretics. They tend to cause contraction of the vessels, not only of the body generally, but of the kidneys in particular, and this contraction may proceed to such an extent that the renal arteries become so much contracted as to arrest the flow of blood through the kidney, and to stop the secretion of urine entirely. As the spasm of the renal vessels passes off, and the pressure returns in the renal glomeruli, the secretion from the kidney becomes greatly increased, so that the suppression of urine is succeeded by copious diuresis.

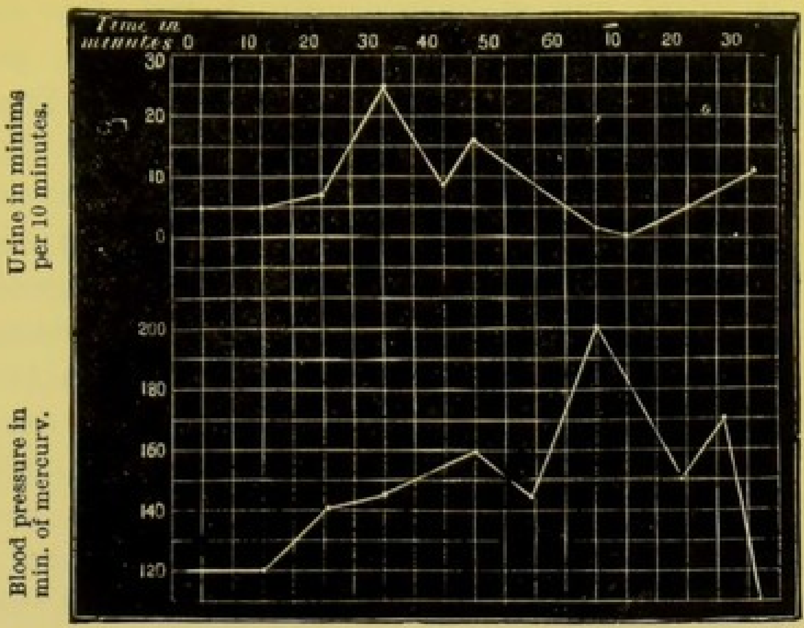

FIG. 96.—Curves showing the effect of erythrophlœum upon the blood pressure and secretion of urine. From "Phil. Trans.," vol. clxvii. At first both rise, but after a certain point, while the pressure continues to rise, the amount of urine secreted diminishes, and when the pressure reaches its maximum the secretion stops entirely.

Digitalis.—We may take digitalis as a typical example of the class of cardiac tonics and diuretics. The action of digitalis is exerted, first of all, upon the involuntary muscular fibre of the heart and of the arteries; secondly, upon the nervous apparatus contained in the heart and arteries themselves; and, thirdly, upon the nerve centres contained in the medulla oblongata, and probably also in the spinal cord. We can see the action of digitalis upon the involuntary muscular fibre, more easily when the drug in solution is applied to the frog's heart; and the heart may be either taken out of the body and placed under a lever, as we have it here (Fig. 88, p. 293), or left in the frog's body. The action does not appear to be at all different if the heart is entirely removed from all its nervous connections, or if it is left in connection with the medulla by means of the vagi. The changes that take place in the movements of the heart have respect both to the rate of the pulsations and to the manner of the pulsations. First of all, when a solution of digitalin is dropped over the heart of the frog, the pulsations become slower, and then an alteration is observed in their character. At each diastole the heart seems to relax less, and the systole becomes stronger and stronger, until at last the diastole seems to disappear entirely, and the frog's heart remains perfectly still in a state of complete systole. The contraction is so vigorous and powerful that every drop of blood is squeezed out of the heart, and it becomes instead of red, as before, almost colourless. I show you a diagram showing the state of the frog's heart before the application of digitalis, during the first stage of the action of digitalis, and during the last stage of the action of digitalis. In the first diagram you will see that both auricle and ventricle are filled with blood; in the second one the auricle remains full, but the ventricle has partially expelled the blood, and you will notice a peculiar appearance upon the heart of little red spots which go on pulsating even after the remainder of the ventricle has become firmly contracted and colourless. These have been supposed to be due to some peculiar action of the drug upon the nerves in the ventricle. For my own part, I am inclined to believe that they are simply due to some alteration in the muscular fibre of the heart, caused by local injury from the forceps in removing the pericardium, because I have observed exactly the same kind of pulsation in the hearts of other frogs to which no drug had been administered. After the drug has exerted its full action upon the frog's heart, and the ventricle is standing still in complete systole, the heart itself is not paralysed. What you see here is a condition, not of paralysis, but of tetanus; so that if you forcibly distend the ventricle by transfusing into it serum or blood under high pressure the pulsations begin again. It is the want of diastole that prevents the pulsations. The heart itself is still capable of rhythmical contraction, but it is contracted so firmly that it cannot show any pulsation. For example, you will understand this better if you try to imitate the movements of the heart with your own hand. If your hand is half closed, you can go on imitating the frog's heart in rhythmical pulsation, but if you gradually contract it more and more until you get the fist clenched, the fist is not paralysed, but it is so firmly contracted that you cannot see any pulsation, although it is quite possible that, if you were to put inside the fist a little ball connected with a manometer, you might still be able to see rhythmical contractions going on by means of the oscillation of the mercury in the manometer, although you could not see any in the fist itself.

I show you the heart of the frog in its normal condition. I will put upon it a little solution of digitalis, and probably we shall find that it will become gradually slower and then contract completely, though not unfrequently in the process of contraction it becomes also somewhat irregular. Now, the same action that digitalis exerts upon the muscular fibre of the heart it exerts also on the muscular fibre of the vessels; and this is an important point to bear in mind. On account of this, it tends to cause contraction of the arterioles, even after the central nervous system is dead; and when it has been administered to an animal in which the carotid artery has been connected with a manometer, it is found that the blood pressure in the carotid falls very slowly after death, and may even remain for several seconds or more without falling very greatly. If you look at the frog's heart which is being treated with digitalis, you will notice that the beats are now becoming slower, and it will probably stand still after awhile in complete systole.

But, besides acting upon the muscular fibre in the heart and arteries, causing increased contraction, digitalis acts also on the nervous mechanisms in the heart and in the vessels. Its action upon the heart in producing this slowness is probably due, not entirely to its action upon muscular fibre, but partly to its effect upon the cardiac ganglia. We do not know very much about the nervous structures in the walls of the blood-vessels, but it is quite possible that these also are affected by digitalis. The nerve centres in the medulla oblongata which regulate the heart and vessels are affected also by digitalis. Thus it acts through the vagus centre in the medulla upon the heart, and slows it; it also acts through the vasomotor centre in the medulla on the vessels, and causes them to contract. We see, therefore, that the slowing of the heart and the contraction of the vessels which digitalis produces are complicated effects depending upon the action of the drug on the nerve centres in the medulla, on the peripheral ganglia or nerves in the heart and vessels, and upon the muscular fibre of the heart and vessels themselves. The result of the action of digitalis on all those structures may be divided into several stages, and these stages are differently arranged by various writers.

If we take a tracing of the blood pressure in an animal, we may divide it fairly, I think, into four stages. I show you a copy of a tracing which Dr. Tunnicliffe has taken (Fig. 97). It

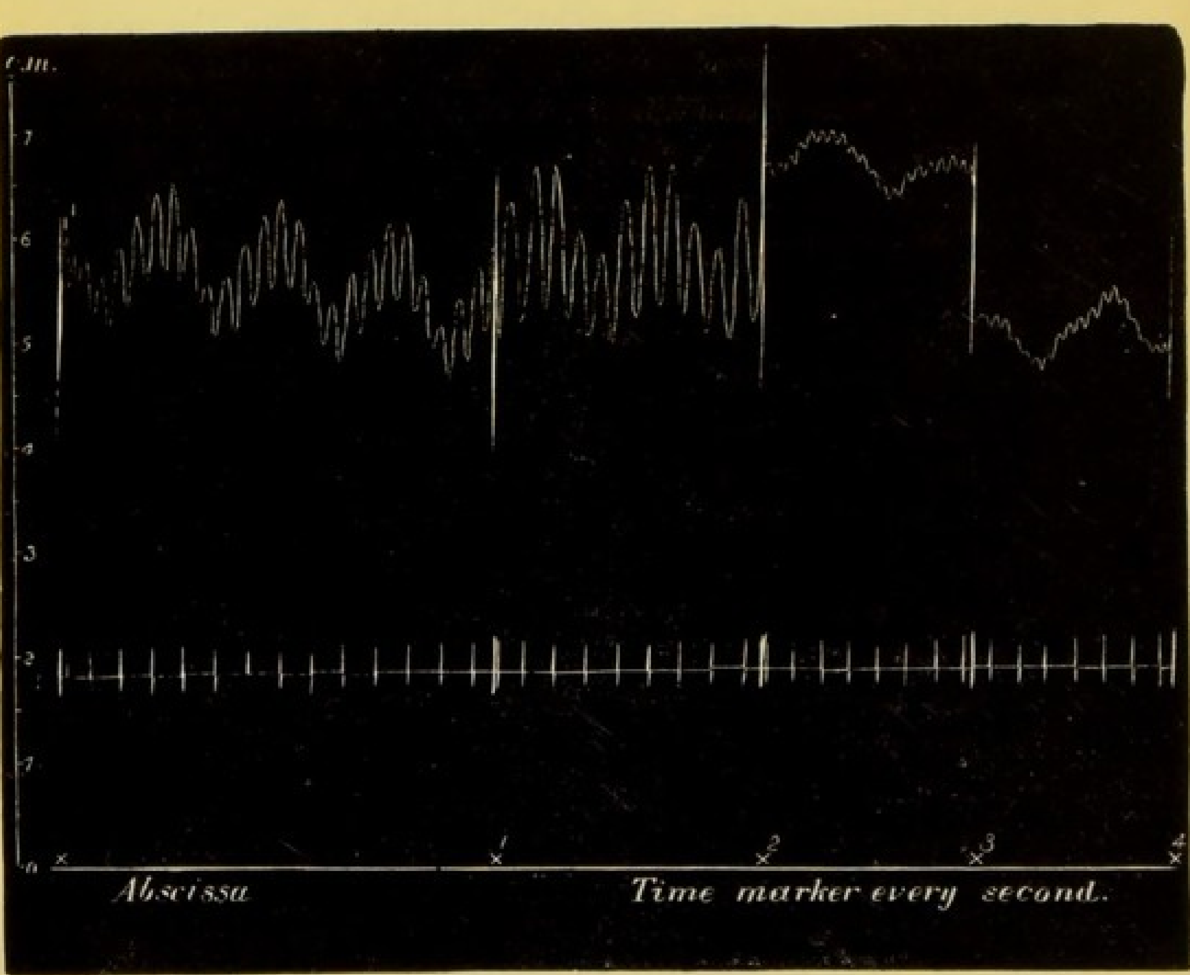

FIG. 97.

shows the four stages in the action of digitalis. The left hand upright line shows the height in centimetres of the blood pressure above the abscissa. The left hand part of the tracing between the marks × and ×[1] on the abscissa shows the normal blood pressure and pulse rate. The part between ×[1] and ×[2] shows the effect of a moderate dose of digitalis in slowing the pulse and raising the blood pressure. The part between $\times^2$ and $\times^3$ shows the second stage, in which the pulse is rapid but extremely small, yet the blood pressure remains very high from contraction of the arterioles. The part between $\times^3$ and $\times^4$ shows the fourth stage in which the arterioles are beginning to relax and the pressure to fall. In the animal after the administration of digitalis the pressure rose, the heart became slower, and the oscillations greater; the reason for this occurrence apparently being that we have the twofold action of digitalis on the heart and on the vessels, viz., the action on the heart through the vagus, causing the pulse to become slower and the oscillations greater, while at the same time, instead of the blood pressure falling, as it would otherwise do from the slowing of the heart through stimulation of the vagus, the pressure has actually risen under the influence of digitalis from the action of the drug in contracting the vessels and increasing the amplitude of the cardiac beats. But, like many other drugs which stimulate the vagus, digitalis in large doses paralyses this nerve. For this reason, in a further stage of poisoning, we find an exceedingly rapid pulse, although there is still a very high tension, which would irritate the vagus roots in the medulla and slow the pulse if the vagus itself were not paralysed. Later on we get the pulse still rapid, but the vessels begin to relax, and the tension, which has hitherto been maintained by their contraction, begins to fall. If we were to carry the action of the drug still further we should probably find the pressure falling gradually to zero, and while it was falling the pulsations might again become slow, as well as weak, from paralysis of the heart itself.

Now digitalis, as I have said, may be taken as a typical example of a cardiac tonic, and in some examinations all that is required of a man to know in regard to digitalis is that it is a cardiac tonic and diuretic; that it slows the pulse and increases the secretion of urine. You can readily see, however, that such knowledge as this is quite insufficient for any man who wishes to discharge the duties of his profession thoroughly, because you might be called to a case where the pulse was quick, where it was feeble, and where the urine had ceased to flow, and if you only possessed the ordinary stock knowledge about digitalis you would say, "This is a case for the administration of digitalis, which is a cardiac tonic and a diuretic." Yet the very symptoms which you observe might be due to an overdose of the drug. This is no fancy picture, because one of the first cases in which I had ever an opportunity of observing the action of digitalis was one of such cases, where a man was found in a state of collapse, with a very rapid pulse and an absence of urine, and, instead of giving digitalis, the digitalis which the man had been taking was immediately stopped, and stimulants such as brandy and ammonia were freely given. If you investigate the action of digitalis upon the pulse of a healthy man or a patient in the wards, you will probably find that, supposing you take 72 as the ordinary pulse of an individual, under the action of digitalis it becomes slower, but if you push it far enough you get this slow pulse gradually transferred into an intermittent pulse, because as the vagus loses its power over the heart you get occasionally a quickened intermission. As the vagus becomes more and more paralysed the quick interpolated beats become more frequent, until at last you get a rapid but fairly regular pulse. As the effect of digitalis passes off, you simply find the pulse going back in the reverse order; *i.e.*, the rapid pulsations become broken by a slow interpolated pulsation. Then the slow beats become more and more frequent, until the pulse is an entirely slow one, and from that you revert to the normal pulse rate.

Now you can readily see how useful digitalis will be in cases of failing heart; that where the heart is beginning to dilate, whether it be from mere weakness in the heart, or from nervous influences, or from the continued strain consequent upon valvular incompetence, digitalis will tend to bring the heart and vessels round to the normal condition.

Precautions in using Digitalis.—But although digitalis is so useful in all cases of cardiac disease, and more especially of mitral disease, it must not be employed without certain precautions. In cases of aortic regurgitation, there are frequently almost no symptoms at all, so long as the ventricle remains strong and is able to carry on the circulation, but in almost all cases of aortic regurgitation there comes a time when the ventricle dilates, the auriculo-ventricular orifices become enlarged, the valves become incompetent, and you get all the symptoms of mitral regurgitation. In the first stage of aortic regurgitation digitalis is usually of little or no use, and, more than that, I think it is sometimes harmful. The reason of this is that in aortic regurgitation you have the blood flowing out of the arterial system, not through one opening into the capillaries, as in health, but through two openings: (1) through the capillaries on into the veins and (2) through the broken aortic valves back into the heart. The consequence of that is that during each diastole the arterial system tends to become empty, and on this account you run a risk of syncope. It is in this class of cases that the sudden death which is so much dreaded by many people usually occurs, and if you prolong each diastole of the heart you can readily see that the risk of emptying the arterial system to such an extent as to produce syncope is increased. As an ordinary rule, then, you do not prescribe digitalis in the first stage of aortic disease at all, but in the second stage, when the symptoms are not those of aortic disease, but of the secondary mitral disease, where the mitral valves have begun to fail secondarily; then digitalis becomes of great use, just as in pure mitral disease. But whereas in mitral disease pure and simple you do not think twice about giving digitalis to an out-patient in a case of aortic regurgitation, you are much more chary about giving it to an out-patient unless this patient be able to follow the directions that you give, and to lie up, so as not to run the risk of any sudden syncope.

In cases where fatal syncope has occurred during the use of digitalis, it generally takes place when the patient rises suddenly from the recumbent to the erect posture, and more especially takes place when, in addition to the erect posture, you have the tension within the abdomen quickly lessened by the patient passing water. If you look up the cases where fatal syncope has occurred during the action of digitalis, you will find that most of them have taken place when the patient has got out of bed to pass water. It is, therefore, necessary to

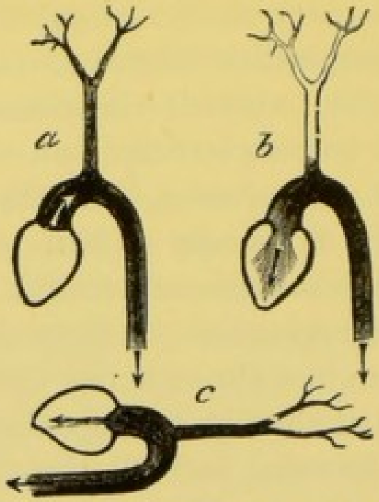

FIG. 98.—Diagram to show the effect of position in aortic regurgitation. In *a* and *c* the carotid and cerebral vessels are full, in *b* empty. *a* is a healthy heart, and aortic regurgitation exists in *b* and *c*.

warn the patient not to get up suddenly from the recumbent to the erect posture, and more especially to be very careful not to get up suddenly to pass water.

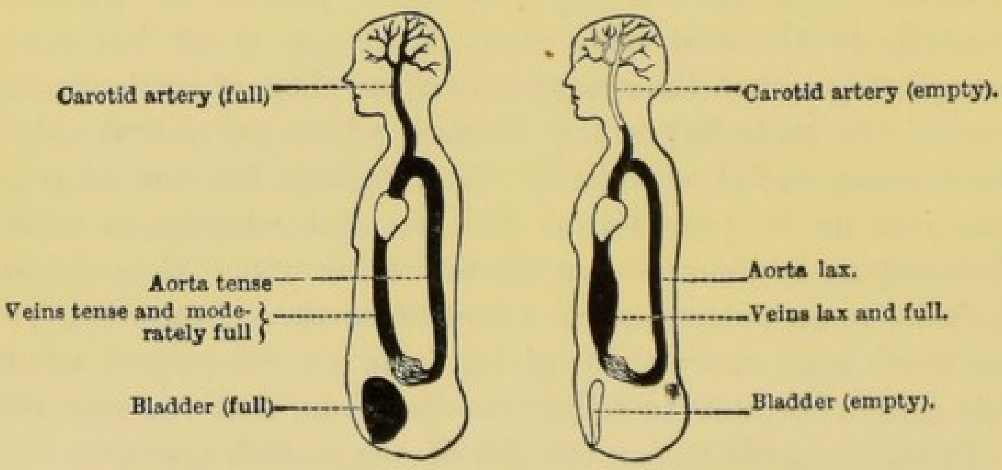

FIG. 99.—Diagram to show the effects on the cerebral circulation of rapidly emptying the bladder.

Then it has been found that frequently, after patients have been taking digitalis for a length of time without any apparent discomfort, the symptoms of digitalis poisoning come on all at once without any very notable warning. The pulse becomes much slower, the patient often becomes sick, and sometimes we may find the pulse intermittent and feeble, the urine at the same time becoming diminished in quantity. In order to avoid this, you generally give your out-patients directions that they are to take the digitalis for a week or 10 days, and then to leave it off for three or four days, again commencing the medicine and again leaving it off for a similar interval. When your patients are in bed, one of the indications that you watch for is sickness, because digitalis, after it has been taken for awhile, very often tends to bring on sickness, and that is the first indication that you must discontinue it for awhile.

Now as a cardiac tonic you would expect that digitalis would be useful in all cases of cardiac weakness, and very likely it might be so, but occasionally you will come across, as I have done, cases in which digitalis, instead of appearing to strengthen the heart, had the reverse effect, and brought on such fits of fainting and threatening of sudden death that the patient was very much alarmed, felt very much worse, and was obliged to give up the medicine. For my own part, I believe that in cases of advanced fatty degeneration of the heart digitalis is distinctly dangerous, and you can readily see the reason why. If you look at a case of advanced fatty degeneration of the heart in the post-mortem theatre, you will find that there are not very many muscular fibres in the heart upon which digitalis can act. Digitalis cannot render a cell that is nearly entirely composed of fat again contractile, however much it may stimulate it. All that it can do is to act upon those muscular cells in the heart that have not become fatty, and stimulate them to increased contraction. Now, if we were dealing with a fatty heart connected with a system of glass tubes instead of with contractile arteries, the administration of digitalis might be useful even in such a case; but you must remember that in giving a patient digitalis you are not acting upon the heart only, but also upon vessels consisting of involuntary muscular fibre, and having a strong contractile power, in which the contractile power is not lessened to anything like the same extent as in the heart by fatty degeneration. Thus you can see that digitalis, instead of helping the circulation in such an individual, may completely put a stop to it. By causing contraction of the muscular fibres of the vessels which are not degenerated, it may raise the arterial tension to such an extent that the fatty heart is no longer able to overcome it, and so ceases to beat.

There is another condition, I think, in which digitalis is also harmful. In cases of advanced Bright's disease the tension, as a rule, is high; the heart in these cases may appear to be flagging. If you give digitalis you may stimulate the heart to some extent, and by this action, as well as by still further contracting the vessels, you may raise the blood pressure even higher than it was before, and what is the result? It is the weakest point that gives way, it is the weakest link in the chain that breaks, and if you have already high tension in a man with degenerated arteries, what happens is that an artery gives way, and hæmorrhage results. Digitalis may, therefore, be very harmful, first of all, in cases where you have a fatty heart with arteries that are not degenerated, because then the heart may stop from the increased resistance opposed to its action, and, secondly, in cases where you have a strong heart with weak, degenerated arteries, because the powerful heart, driving the blood into the arteries under greater pressure, simply bursts one of the weaker vessels, and hæmorrhage in one part of the body or another results, generally in the brain. These are the conditions under which you should administer digitalis with great care, if you give it at all.

Active Principles of Digitalis.—Now there are, I think, certain differences in the action of the different preparations of digitalis. Digitalis does not contain one active principle alone; it contains no less than four at least, perhaps more. The following names have been given to these four principles:—

Digitalein.
Digitalin.
Digitoxin.
Digitonin.

All the first three have an action very much like one another, an action such as I have already described; digitonin has a different action altogether. It seems to have an action very much like that of saponine, and to be to a great extent antagonistic to the other three, so that, in the place of tending to cause contraction of the vessels, it apparently tends to cause dilatation, and it is just possible that the advantage which digitalis possesses over most of the other cardiac tonics is that it has, in combination with the three contracting principles, the digitonin which seems to have an opposite effect. Now, digitonin is, I think, present in larger quantity in the infusion of digitalis than in the tincture, and if you take a little infusion of digitalis and shake it up you will find that it froths almost as if you had a solution of soap or of saponine.

The infusion of digitalis is often regarded as a more active diuretic than the tincture, and you will find many people, in cases where they wish to produce an action upon the heart, give the tincture; but where they wish to cause profuse diuresis they prefer the infusion. I think it is possible that they are right, and that the greater diuretic power of the infusion is due to the larger proportion of digitonin in it. All infusions of digitalis have, I think, not always the same power. I believe that there is a great difference in the infusions according to the character of the plants from which they have been prepared. My reason for thinking this is that in Edinburgh the infusion of digitalis is almost never given in less doses than half an ounce, whereas we find here that the infusion of digitalis is rarely given in such large doses. It is generally given in doses of 1 to 2 drachms. I believe that the reason for this is simply that the infusion as employed here is made from plants possessing a larger proportion of active principles than those which occur farther north.

There are many other drugs which have an action almost identical with that of digitalis. I say "almost identical" because there are differences, slight differences which have not been completely worked out, and which we cannot exactly classify. One of the other drugs that are used very much in place of digitalis is strophanthus. The tincture of strophanthus has been made of such strength that it may be employed in the same dose as tincture of digitalis. My own belief is that strophanthus acts more upon the heart and less upon the vessels than digitalis does; so that I think it ought to be preferred to digitalis in cases where you wish to stimulate the heart more powerfully, and not to effect any changes in the vessels. There is another drug, erythrophlœum, which has very much the same action as the two just mentioned, but it appears to me to act rather more upon the vessels and less upon the heart than either strophanthus or digitalis. We have also the adonis vernalis, convallaria, and cactus grandiflora, all of them having very nearly the same action; and occasionally you find that some of those drugs that I have named may succeed when the ordinary ones fail. Broom contains an alkaloid, sparteine, which has an action on the heart very much like digitalis. It is now used much in the same way as digitalin, and you will find that one of the remedies that are chiefly employed as a diuretic is the decoction of broom. Squill, which is used so much as an expectorant, has another principle, scillain, which acts also like digitalis. What I have said about digitalis applies also to these other drugs.

Cardiac Sedatives.—Digitalis, which is now considered to be a cardiac tonic, used, when I was a student, to be regarded as a cardiac sedative, as a drug which was not to be used in cases of feeble heart. It was looked upon as a drug which lessened the power of the heart, and slowed it, and on account of this slowing action it was called a cardiac sedative. Now, in certain cases, it does act as a cardiac sedative, because it slows the heart, and this is perhaps more particularly noticeable when you have to deal with a heart which has become, as it is termed, "irritable" in consequence of over-exertion. This irritable heart is to be found in soldiers, from the exertion of carrying heavy knapsacks to which they have not been accustomed for many miles; and you find it also in out-patient practice at this Hospital occurring amongst coal-heavers and stevedores, and sometimes amongst carmen who have to lift heavy weights into their car. The heart becomes so irritable that they get palpitation on the least exertion, and in such cases digitalis seems to have the power of lessening the irritability of the heart.

I mentioned to you before that atropine or belladonna has the power of lessening the irritability of the heart also; so that extra pressure put on the ventricle does not produce increased pulsation after the administration of atropine, as it would otherwise do. In some of those cases of irritable heart in stevedores and coal-heavers I have found tincture of belladonna pushed to a considerable extent, until the mouth was slightly dry, very useful. Curiously enough, however, I have sometimes noticed that although it was very useful when given for the first time, if, after they had recovered, the patients disregarded the caution that I had given them, and subjected their hearts again to a strain, thus bringing on the palpitation a second time by overlifting, atropine or belladonna did not seem to have quite the same beneficial effect as on the first occasion.

Nicotine.—There is another drug which has, perhaps, a more powerful action upon the vessels than any other, and that is nicotine. If nicotine be injected into the circulation, it slows the heart and stimulates the vagus most powerfully. In large doses it paralyses the vagus. It raises the pressure so tremendously that I have seen the swimmer of a manometer driven right out of the apparatus by it. I do not know that there is anything that causes such a tremendous contraction of the vessels and raises the blood pressure to such an enormous extent as nicotine, except, perhaps, the extract of supra-renal capsules, which has an action almost identical with that of nicotine. It would almost seem, then, that healthy men have a sort of tobacco manufactory inside so long as their supra-renal capsules are in working order, and that this tends to keep their blood pressure up to the normal. In cases where the supra-renal capsules undergo atrophy, the blood pressure tends to sink, and the patients become exceedingly feeble. If nicotine be pushed to too great an extent it is a powerful cardiac poison, and it has a curious effect upon the heart, which, I think, varies according to the kind of tobacco employed. The tobacco which is, I think, known by the name of "pigtail," occurring in long coils, seems to me to bring on an affection of the heart characterised by extraordinary irregularity. It is impossible to describe the rhythm in words, but it is something like this, | | | | ''''' |, and is apparently due to partial paralysis of the vagus; and so long as the tobacco is continued this irritability of the heart is likely to last. A curious point about it is that a very little tobacco will keep up this irritability, and that sometimes it is necessary to tell the patient not merely to lessen the quantity of tobacco that he is smoking, but to stop it altogether until the heart becomes regular. In cases where Cavendish is employed, I do not think that this irregularity of the heart is so marked. In the lower classes of hospital patients this kind of irregular heart, which I have tried to describe, is very common, but amongst the upper classes, who smoke better tobaccos, the result of oversmoking is more frequently shown in sudden faintness. The man falls as if he were shot.

One day an old friend of mine, who was secretary to a learned society, came to me and said that he had had an awkward accident. He was a tall man, 6 feet 2 inches in height, and strongly built. While reading the minutes at the meeting of the society on the previous night he suddenly fell down perfectly unconscious, and he felt very much alarmed at this sudden failure of his heart. I knew his habits, and I said, "You have been smoking too much." "No," he said, "I don't think I have." "Have you got any different cigarettes from what you have been used to smoke?" "Oh yes," he said, "I have got some different cigarettes, but they are very mild." "Have you not been smoking more than you used to?" I asked. "Perhaps I have," he said. I replied, "Get rid of the cigarettes you don't know, and use only those you do know, and very likely you will have no more accidents." He went back to his former cigarettes, stuck to them, and never had another faint. Another case was that of a friend of mine also, in which the effect of tobacco was conjoined with emotion, and although the tobacco alone or the emotion alone would not have done it, the two together simply made him drop in the street as if he had been shot. He had been smoking some cigars as he walked along to a house where he had some disagreeable business to transact. When he got to the door of the house he simply fell down in the street quite unconscious, and I think in his case it was the tobacco conjoined with the emotion which made him drop in this way.

In cases of oversmoking, one needs to be very careful. A very curious note was made by Professor Fraser, of Edinburgh. For some years I examined in materia medica in Edinburgh University, and used to stay with Professor Fraser, who was an old friend of mine. After the papers had been examined for the day we often sat together while he was smoking. He told me that he was the only one of a clique of students who had been in college at the same time as himself who had continued to smoke, with one exception. Fraser himself had always been a moderate smoker, but the others had often smoked heavily, and they had all ceased to smoke as they got towards middle life on account of frights very much like those that I have just described to you. Fraser himself had continued to smoke always moderately, but there was only one man in the whole clique who had continued to smoke, and to smoke heavily, up till middle life. Just, I think, a year after this conversation with Professor Fraser, the colleague, also a professor, who had been the heavy smoker, dropped suddenly down at a garden-party dead; so that was rather a striking commentary upon Fraser's remarks of a year before.

Cardiac Depressants.—There is another drug which tends, like digitalis, to slow the heart, but does not tend to raise the blood pressure; that drug is aconite. The *modus operandi* of aconite we simply do not know, but it does slow the heart to an extraordinary extent.

There is one very curious point about it, viz., that aconite given in small doses appears to slow the pulse much more than larger doses; so that 1 minim of the tincture of aconite repeated every hour or so will slow the pulse more than doses of 10 minims. 10-minim doses of aconite do certainly sometimes relieve neuralgia in a wonderful way, but I have always been afraid to give such large doses, and so I have generally used small doses, giving them more frequently. Aconite is a remedy amongst homœopaths of great repute, and the tincture is diluted in making up their preparations. Many of you may have seen the account of a case being thrown down heavily at one of the railway stations, and a liquid flowing from it which was apparently spirit. It had an agreeable smell, and one of the porters, kneeling down, drank some of this spirit, and died in a very short time afterwards. It turned out that this was homœopathic mother tincture of aconite, which is a very strong preparation indeed. Even the ordinary tincture is sufficiently strong to slow the pulse very markedly. Aconite is very useful in cases of commencing inflammatory disease; for example, in cases of tonsillitis, where the inflammation is just beginning, it appears to be often cut short by the administration of aconite. Aconite in children's diseases which are accompanied by a rise of temperature is a favourite remedy. There you must give it in very small doses, and you can repeat them frequently if you are watching the child. You may give as a dose a fourth or a third of a minim, or even less, and repeat it say every half-hour until you find that the temperature has fallen, and the pulse is slower.

Vascular Stimulants.—Another class of drugs are those known under the name of vascular stimulants, or stimulants of the circulation. There is this great difficulty in speaking of stimulants or sedatives of the circulation: that if you stimulate both the heart and vessels at the same time, the action of the one tends to counteract the effect of the other. For if you cause contraction of the vessels at the same time as you stimulate the heart to contraction, the increased blood-pressure tends to excite the vagus roots and slow the heart. On the other hand, a drug which weakens the heart may possibly increase the circulation by dilating the vessels, and thus acting as a "vascular stimulant." It is therefore best perhaps to speak not of cardiac depressants and vascular depressants, nor of cardiac stimulants and vascular stimulants, but rather of stimulants of the circulation.

One of the most powerful stimulants of the circulation, which increases the flow of blood and tends to keep the heart active, is alcohol. When administered to an animal or to a man, the vessels appear to dilate under its influence, the flow of blood through them becomes more rapid, and the pulse stronger. On account of its power of dilating the cutaneous vessels, the surface of the skin becomes warmer. Although this is often an advantage, it is sometimes a disadvantage, as I mentioned to you before, if the patient is to be exposed to a very low temperature. But if the patient is feverish, the dilatation of the vessels in the skin produced by alcohol is of considerable service in tending to bring the warm blood from the centre of the body right under the cooling influence of the skin, and thus to reduce the patient's temperature. In the case of healthy people, I do not think that alcohol is of much use as a food. I believe it to be a food to a certain extent even in health, and especially when those who take it have much open-air exercise, but in cases where you have a high temperature I have almost no doubt whatever that alcohol is not merely a stimulant to the circulation, but is really a food. Under the influence of the high temperature of the body, alcohol probably undergoes oxidation to a larger extent than it does in the healthy body, and thus it acts as a true food and takes the place of other foods.

Another stimulant that is very much used is ammonia, and this may be given not merely internally for its action after it has been absorbed, but for its action before absorption. Alcohol does not only act upon the circulation by its effect after absorption into the blood, and consequent application to the nerve centres and the heart themselves: it acts also reflexly, so that if a person is fainting, and you give him a dose of pure brandy, this stimulates him, and probably prevents the faint, before it has had time to be absorbed from the stomach. It stimulates the mucous membrane powerfully, and through the nerves of the stomach it acts as a stimulant reflexly upon the cerebro-spinal nerve centres and the heart. In the same way ammonia taken into the stomach stimulates the heart reflexly, and ammonia held before the nose has also a powerful stimulating action upon the circulation. I was once demonstrating the action of ammonia before a class here many years ago, and showed that if you held either ammonia or chloroform before the nose of a rabbit the heart stopped instantaneously. This stoppage of the heart takes place reflexly through the 5th nerve as an afferent, and through the vagus as an efferent nerve. After the lecture was over, a student came up to me and said: "If ammonia held before the nose stops the heart, how is it that it is of use in fainting? It ought to be exceedingly bad in fainting, and yet everybody knows it is good." Well, I simply did not know. I said: "I think it may possibly be that it tends at the same time to cause a deep inspiration, and thus stimulates the heart indirectly." But I was not satisfied with this explanation, and so I put the question to the test of experiment. I found the answer to be this: At the same time that you stop the heart through the vagus by ammonia or any other irritating volatile substance held before the nose, you stimulate reflexly the vasomotor centre, cause contraction of the arterioles, and raise the blood pressure enormously. So much is this the case, that in an animal in which I had produced a great fall of the blood pressure by Goltz's experiment of tapping strongly upon the intestine I was able to raise the blood pressure by more than one-third by simply holding ammonia before the nose. Therefore, you see, ammonia is a powerful stimulant to the circulation. Some time ago I saw a curious note in an Indian medical paper. A gentleman was walking one day along a road in India, and he saw another man riding past. After the rider had gone a short distance, his horse suddenly swerved, and the rider was thrown heavily to the ground and fell on his head. As the foot-passenger walked up to him to see what had happened, he found three or four Hindoos apparently engaged in throttling the unfortunate man. One Hindoo had his hand over the poor fellow's mouth; another had hold of his nostrils, and was holding them tight. The foot-passenger thought they were trying to kill the man preparatory to robbing him, but when he asked them what they were doing, they said: "Oh, bringing him round; we always do it this way." And, sure enough, the man did come round, and you can easily see the reason for what they were doing. They were effecting in a different way the same change in the circulation which you would do by holding ammonia, or what old wives used to do by holding burning feathers, before the nose: they were raising the blood pressure by contracting the arterioles, only, instead of using a strong scent applied to the nose to cause reflex contractions, they were causing contraction of the arterioles by rendering the blood venous, and thus stimulating the vasomotor centre in the medulla oblongata directly instead of reflexly.

LECTURE 18.

Stimulating effect of asphyxia—Of dilatation of cerebral vessels—Organic nitrites—Alcohol—Alcohol in post-febrile collapse—Guideswit's use—Salvolatile—Spirits of nitrous ether—Nitrite of amyl—Isobutyl nitrite—Hydroxylamine—Erythrol tetranitrate—Vaso-constricting and dilating effects of glandular extracts—Description of experiment—Mixed action of digitalis and nitrite of amyl—Effect of asphyxia on the circulation—Iodide of potassium in angina pectoris—Atheroma—Pumping action of contracting and relaxing muscle in removing waste products—Value of training.

GENTLEMEN,

At the end of last lecture I was telling you of a plan adopted in India for recovering people from a faint by simply holding the hand over the mouth and nose, so as partially to suffocate the patient. By this means the blood becomes more venous, the blood pressure rises, and the patient tends to recover from the faint. The blood pressure here is raised generally throughout the whole arterial system, but we may raise the local

FIG. 100.—Tracings from the brain of a dog after trephining, showing the influence of position on the cerebral circulation. In the upper tracing the vertical line shows when the head of the dog was lowered, and in the lower tracing when the head was raised (Salathé).

pressure in the arterial system of the head by means of position, as, for instance, by inversion. I have had occasion to mention this before in treating of the action of anæsthetics, when I told you that in many cases where there was a tendency to fainting during an operation, or during the administration of an anæsthetic, the head of the patient should be lowered below the level of the body by tilting the end of the table or bed upon which the patient's feet were lying, so as to allow the blood to flow more readily towards the head, and thus to raise the pressure in the vessels of the brain and stimulate the respiration, which had begun to fail.

Now, there is another way of increasing the circulation through the brain besides that of simply raising the blood pressure in it, either locally or generally, and that is by dilating the vessels of the brain. If you dilate the vessels of the brain, and especially if at the same time you tilt the body so as to allow the blood to flow more readily towards the brain, you increase the circulation through it, and get restoration of respiration more readily than you would otherwise do. The means generally employed to dilate the vessels is the application of a nitrite, and more especially an organic nitrite, *i.e.*, a nitrite in which you have got the nitrous acid combined with an organic radicle. There are some other drugs which have a distinct dilating action upon the vessels, but do not act so quickly as the organic nitrites. At the same time they tend to increase the pulse rate and to increase the power of the heart's action. These drugs are alcohol in its various forms and ammonia or carbonate of ammonia. Both are powerful stimulants, and the most universal stimulant in the world probably is brandy or whisky, or some other form of spirit, which is used in order both to stimulate the heart and to dilate the vessels. As I mentioned to you before, in large doses alcohol tends to depress, in the same way as chloroform does, every organ of the body, but in small quantities its action is not that of a depressant, but that of a stimulant. In cases of fever it is, as I have mentioned, in all probability a food.

Alcohol in Post-febrile Collapse.—It sometimes comes to be rather a delicate question how far you are to push alcohol in cases of disease, and more especially in cases of febrile disease, *e.g.*, of typhus or typhoid fever. Typhoid fever is common, but cases of typhus are so rare now that they hardly come into consideration. The rule for the administration of alcohol is a very simple one. It is to sit by the side of your patient for awhile and watch him after the administration of a dose of alcohol, and if you find that the alcohol brings back the various functions nearer to the normal then it is doing good; if the functions of the organs diverge further from the normal after the administration of alcohol, then it is doing harm. I use this means of expressing the action of alcohol advisedly, because if we take the different functions we find that a special rule will not include them. Thus the pulse may become quicker or slower after the action of alcohol, and yet the question whether good or harm has been done depends upon the condition of the pulse beforehand; that is to say, if the pulse has been abnormally slow, and is quickened by alcohol, it is doing good, for it has brought the pulse nearer to the normal. On the other hand, if the pulse has been abnormally quick, and is slowed by the alcohol, it has again been brought nearer to the normal, and hence the alcohol in this case also has done good. But in the one case the alcohol has done good by quickening the pulse, in the other case by slowing it; so that, in order to convince ourselves of the beneficial action of alcohol, we must have regard to its relative, and not to its absolute, effect upon the pulse; in other words, we must not say that simple quickening or slowing of the pulse by alcohol is good unless we can show under what conditions the pulse was beating before the alcohol was given. The same rule is applicable to the tongue. If a tongue which was previously dry becomes moist after alcohol, then it has done good; in the same way, if the skin were too dry and hot before we gave alcohol, and the alcohol brings it back more to the normal, makes it cooler and moister, then the alcohol is doing good. If, on the contrary, the alcohol makes the skin drier and hotter in fever, then it is doing harm. But if the skin were cold and bedewed with sweat in collapse, and alcohol makes it warmer and drier, it is again doing good.

It is sometimes exceedingly difficult to estimate the quantity of alcohol to be used. It varies, and I do not know that I can give you any guide except the rule that I have just mentioned

The fact that a man has been accustomed to drink large quantities of alcohol when in health makes it often necessary to give him in disease a quantity so large that it would certainly be injurious to an ordinary patient. You must take into consideration the habits of the patient, as well as his disease, in judging of the amount of alcohol to be given.

Ammonia has certain advantages over alcohol. For one thing, it acts, if anything, rather more quickly. A second advantage is that it tends more than alcohol to cause catarrh of the stomach, and leads, in large doses, to vomiting. This is in itself, you will say, a disadvantage, because you cannot give it to the same extent that you can alcohol, and, no doubt, in a case of fever this is a great disadvantage to ammonia. You cannot push ammonia as a stimulant in fever in the same way that you can push alcohol, but the advantage is that the patient is not likely to get into the habit of taking ammonia as a stimulant, as he might of taking alcohol as a stimulant.

I have been much struck by the fact that in a large proportion of women who have been brought to me as patients, and whose friends have complained that they took more alcohol than was good for them, there was distinct feebleness of the heart, and in many of them I detected a distinct mitral murmur. Now, there is a story that a lady took much more alcohol than was good for her, and she laid the blame of this upon the doctor, who had told her that it was necessary for her to take alcohol because she had a feeble heart. The friends did not quite believe this, and they insisted upon seeing the prescription. After a great deal of pressure on the part of the friends, and delay on the part of the patient, it was finally produced. It turned out to be forty years old! On the same piece of paper there was a prescription for some pill or other, and the friends asked her if she had been taking the pill as continuously as she had the alcohol, whereupon she became very indignant, and said: "Do you think I am a fool?" But the alcohol was what she wished, and so she continued to take it for 40 years upon the strength of the one prescription. One requires, therefore, to be rather careful in prescribing alcohol for cases of chronic cardiac weakness, because the prescription is only too agreeable to many of our patients, and they may get into the way of taking spirits to a much greater extent than is good for them, especially as they find their feelings of weakness and lowness are relieved by spirits, for a time at least. At first they take alcohol as a medicine; afterwards they get into the habit of alcoholic vice. So that in cases of chronic cardiac disease, with tendency to faintness, ammonia is a better stimulant to rely upon than alcohol. But, on the other hand, in cases of acute illness, and more especially in febrile conditions, alcohol is a better stimulant than ammonia.

Ether has somewhat the same advantages and disadvantages as alcohol. For one thing, it is less agreeable to take, but its action is much the same, and when the use of alcoholic liquors was put down by Father Matthew in a great part of Ireland, ether became used as a stimulant in place of alcohol, and many people continue to use it regularly now as a stimulant. There is one form of ether, the spirit of nitrous ether, which has a more powerful action than any of the others in dilating the vessels, and it is a very useful stimulant indeed in cases where you have a high arterial tension, and wish to relieve the action of the heart by lessening the resistance it has to overcome. In regard to the dose of spirit of nitrous ether, I had a very useful lesson some years ago. I was called to see a patient suffering from mitral disease, and he was in a very bad condition indeed; the heart seemed to be failing. I advised that spirit of nitrous ether should be given in half-drachm doses every quarter of an hour until 2 drachms had been taken. When I saw the patient the next time I found that, instead of half-drachm doses having been given until 2 drachms were taken, 2 drachms had been given until the patient had taken the whole contents of the bottle, amounting to 2 ounces, with the result that the patient was very greatly benefited. It had acted as a very powerful stimulant, and brought him round from the condition of collapse in which he then was. Spirit of nitrous ether is a medicine which is used very largely indeed in order to dilate the vessels, and thus act as a febrifuge. It dilates the vessels of the skin and also the vessels of the kidney, and the place where this dilatation occurs chiefly depends upon some determining circumstance.

If you keep the vessels of the skin cool, and consequently contracted, the vessels of the kidney dilate more than they, and thus the spirit of nitrous ether tends to act as a diuretic. But if you keep the skin warm the vessels in it dilate, and the spirit of nitrous ether acts as a diaphoretic. It acts, however, generally throughout the body, lessening the arterial tension by dilating the vessels.

Action of Organic Nitrites and Nitrates.—There are some other nitrites, however, which act more quickly, and one of the most rapid is nitrite of amyl. This drug when inhaled causes very rapid dilatation of the vessels indeed, with flushing of the face, a feeling of fulness in the head, and a very great fall of the blood pressure. On account of this fall of blood pressure, it eases the heart at once when this organ is unable to overcome the resistance which is opposed to it. Like many other hollow organs, in fact like all hollow organs composed of involuntary fibre, the heart is very sensitive to resistance inside it. Most of you know a story told of one of the surgeons to this Hospital, who, many years ago, went to a theatre one night and saw a man on a bench in front of him fidgeting about, and apparently in very great pain. All at once the man seemed to get perfectly quiet and comfortable, and the surgeon said, "That man is going to die." He diagnosed that the man had got a distended bladder, which had finally ruptured, giving him ease for the time, but leading to peritonitis, and death afterwards. The bladder when distended is a cause of very great pain, and some of you may have read in your classical studies that that horrid brute Tiberius was accustomed to torture some of his victims by tying a string round the penis so as to prevent evacuation of the bladder, and then making the unfortunates drink a quantity of wine. The bladder became enormously distended, and the pain thus caused was excruciating. In the same way, if the colon becomes distended by flatus, or the stomach by gas, the pain is exceedingly great, and it appears to depend upon the contraction of the involuntary muscular fibres, of which the organ is composed, against a resistance which they are unable to overcome. When the heart contracts against a resistance which it cannot overcome, the pain in the heart also becomes great

You can readily see that the excess of work to be done over power to do it, which causes the pain in these cases, may depend upon the fact either that the peripheral resistance in the vessels has been increased above the normal, or that the power of the heart to overcome the resistance has been lessened below the normal. In either case, the resistance becomes too great for the heart. In cases of angina pectoris, this condition appears to obtain, and there you frequently find that there are both conditions to deal with, viz., a heart which has become enfeebled and a resistance which has become increased above the normal.

Many years ago, when I was a resident physician, I had a case of angina pectoris under my care. I used to go at all hours of the day and night and take tracings of the man's pulse. I found that during the attack of angina pectoris the pulse became very hard indeed, and the oscillations became very small. He had a certain amount of aortic regurgitation, and his normal pulse wave was very large, somewhat like this (Fig. 101). As the man's pain came on, the pulse became

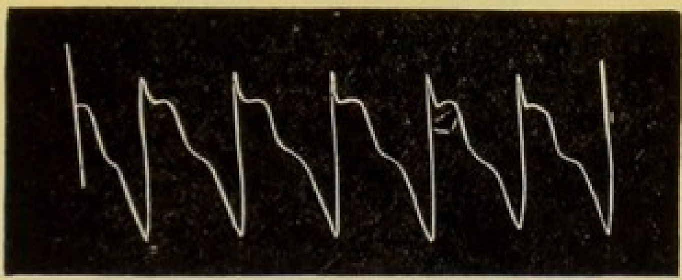

FIG. 101.—Normal pulse-tracing of a patient suffering from aortic regurgitation and angina pectoris.

smaller and quicker, like Fig. 102, and when the pain was excessive the pulse became very rapid, but hardly perceptible

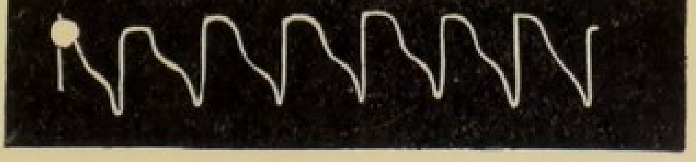

FIG. 102.—Tracing of the same pulse during temporary relief of pain by nitrite of amyl. The pain returned after a few minutes, and this tracing may be regarded as showing the alteration in the pulse which occurs during the onset of the pain.

(Fig. 103). Now, it is almost impossible to explain such a change in the pulse as we have here without assuming that the

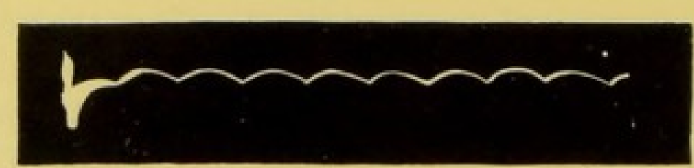

FIG. 103.—Tracing of the same pulse during severe anginal pain.

peripheral arterioles had become enormously contracted. It therefore occurred to me that if one were able to dilate the arterioles the man's pain ought to subside. I knew that

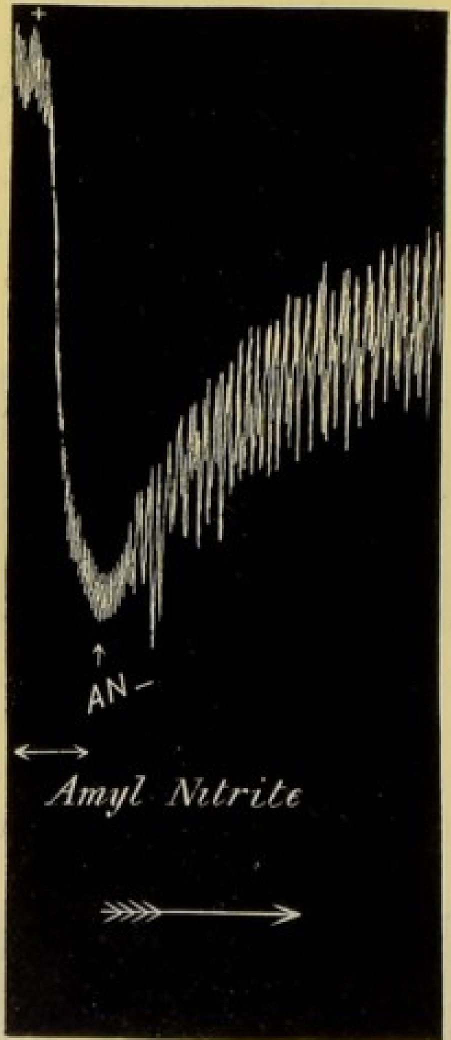

FIG. 104.—Tracing showing the action of amyl nitrite on the blood pressure. The point where the administration was begun is marked by a cross, the point where it was discontinued by a small arrow. The horizontal double-headed arrow indicates the zero point of pressure; the single-headed arrow indicates the direction in which the tracing is to be read.

nitrite of amyl had the effect of dilating the vessels, and I tried it, with the result that no sooner had the flushing of the face occurred, and the vessels begun to dilate, than the pain disappeared. Since that time nitrite of amyl has become recognised as a regular remedy for the paroxysms of angina pectoris. There are various other nitrites which have just the same effect: sodium nitrite, propyl nitrite, isobutyl nitrite, and even the

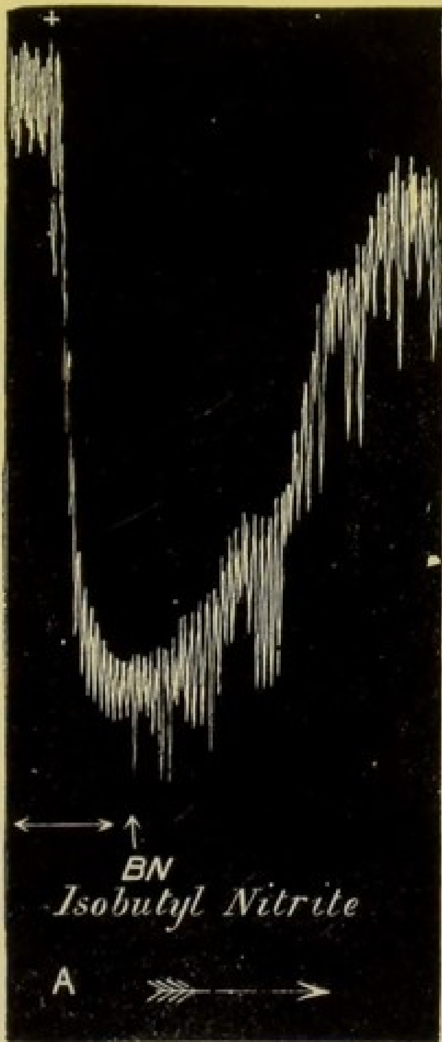

FIG. 105.—Tracing showing the action of isobutyl nitrite on the blood pressure. The indications on the tracing are the same as in Fig. 103.

ethyl nitrite, some of which is contained in spirit of nitrous ether. The difficulty about these drugs is that, although their action comes on rapidly, it is transient, with the exception of that of the sodium nitrite. Then they are somewhat troublesome to carry about, although this difficulty has been overcome to a certain extent by enclosing them in small glass capsules, which may be carried about in the pocket, and broken whenever the fit of angina comes on. The liquid is thus set free, it is sucked up by a little silk which covers the capsule, and the patient simply puts the silk to his nose and inhales the vapour, when the paroxysm is generally at once relieved. Another substance, however, has almost an identical action with that of nitrite of amyl, although it is not a nitrite, but a nitrate, and that is nitro-glycerine. This is a nitrate, or rather a trinitrate, of glycerine, but it seems to undergo a change in the body into a nitrite, and there it produces the same rapid dilatation of the vessels as the nitrites. Another body of the same class is erythrol tetranitrate, which appears to exert a less extensive, but a more lasting, action than nitro-glycerine. Another substance which has an action almost exactly the same is hydroxylamine, and this may be employed in the same way as these

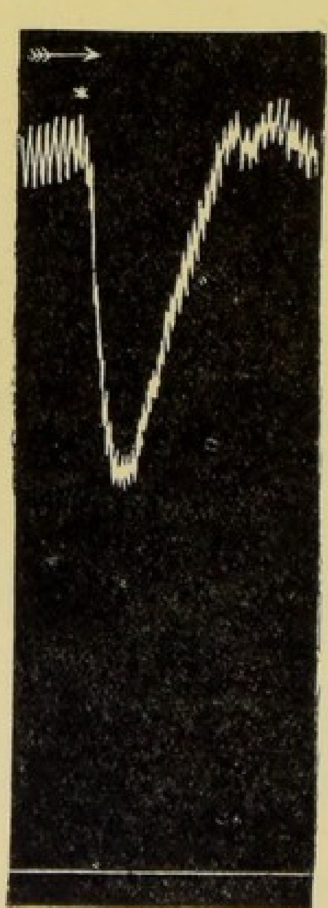

FIG. 106.—Action of hydroxylamine hydrochlorate on blood pressure.

others in the treatment of angina pectoris. You will find in the Hospital reports for 1876 a research on the physiological action of nitro-glycerine by Dr. Tait and myself, and you will also find in the reports of a year or two ago an account of the action of hydroxylamine in cases of angina pectoris.

In the experiment which Dr. Tunnicliffe is kindly going to show you on a rabbit, as I have not at present a licence, we hope to be able to demonstrate the effect of nitrite of amyl and also of digitalis upon the circulation. The easiest way of using nitro-glycerine is in tabloids which the patient can carry about in a small box or bottle, and I think the best plan is for him to nibble a bit or eat a whole tabloid or more, according as the necessity of the case may demand. The vaso-dilators are useful also in cases where the tension is generally high, as in chronic Bright's disease, more especially when the vessels are not only contracted, but the heart is beginning to undergo fatty degeneration. In those very cases where you find that digitalis is likely to do harm rather than good, the nitrites will probably be beneficial.

I should also mention that the inorganic nitrates are useful in reducing blood pressure, but they act much more slowly, and to a less extent, than the nitrites. It would appear, therefore, that the nitrates, such as nitrate of potash, undergo a certain amount of reduction in the body, forming nitrites, which then produce their dilating action upon the vessels, so that nitrate of potash, which is an old remedy in cases of disease of the kidney, has the effect of gradually lessening the tension in the vessels in cases of chronic Bright's disease.

A very curious question now arises which is difficult to answer: Why is arterial tension so much increased in cases of chronic disease of the kidney? Practically we do not know, but in all probability the increase is due to the presence in the blood of some organic substance or substances. I mentioned to you before that the supra-renal capsules have the power of secreting a substance which causes great contraction of the vessels, and extracts of other glands have a power of dilating the vessels, so that the extract from the thyroid, for example, dilates the vessels, and tends to cause a freer circulation through the body

Sometimes this is accompanied by a feeling of great heat on the surface and rapid action of the heart, and in cases where the thyroid gland is affected by the disease known as exophthalmic goitre you find that the surface of the body is generally warm, the vessels are dilated, and the heart beats are very rapid.

Although the animal is fully under the influence of an anæsthetic which of itself somewhat lowers the blood pressure, you will now, gentlemen, be able to see the pulsation of the heart by means of the little flag which is attached to the pen of the manometer, and by observing the height of the flag you will have a measure of the tension in the artery with which the manometer is connected. We will give a little nitrite of amyl, and you will probably see the flag fall pretty rapidly.

In cases where you are dealing with a mercurial column of this sort, if you want to estimate the actual fall of pressure, you have to double the fall, as shown by the flag, because we are dealing with the two limbs of the manometer. You see that, on the administration of nitrite of amyl, the flag has fallen fully an inch, which corresponds to a fall of two inches in the arterial tension.

We will now show the effect of the injection of digitalis. You will probably find that the heart will become slower, and the pressure will rise. The pressure is beginning to rise, but our animal is a feeble one. The oscillations are greater with each beat. You can thus observe that the effect of the digitalis upon the vagus is fairly well marked. It is just a question whether the effect of the amyl in dilating the vessels will not counteract the contracting influence of digitalis upon them. The nitrite appears so far to have more than counterbalanced the digitalis. Of course we are dealing here with a mixed experiment; the nitrite has not been eliminated, and, therefore, we should expect the effect of the digitalis upon the vessels to be very greatly modified by the action of the nitrite. The vessels are not so contracted as they would have been if we had given digitalis alone. When the nitrite has become eliminated, we shall get the effect of the digitalis on the vessels, and the rise of pressure will be marked.

In our experiment you now observe that the effect of the nitrite of amyl is passing off. The pressure is rising, and will probably rise still higher. This experiment also shows you the effect of mixed drugs. There has been frequently an attempt to simplify the administration of medicines, and to gain a greater knowledge of the action of individual remedies by giving them alone instead of combining them, as in the old practice of polypharmacy. Long ago physicians were accustomed to give a very large number of drugs together, on the same principle that a man who is not a particularly good shot wants a scattering gun, so that, if one shot misses, some other will take effect. Old physicians would give as many as forty drugs in one prescription, trusting that if some one of the component drugs did no good, others would. This, of course, was an abuse. In the attempt to lessen it, and to get a more exact knowledge of the action of individual drugs by giving them alone, it was found that very often an individual drug does not act nearly so well as a combination of drugs, and you see in this experiment we have got two distinct actions: on administering the nitrite of amyl, we got dilatation of the vessels and a fall of blood pressure; by giving digitalis at the same time, we did not raise the pressure very much. We got, however, the effect of digitalis upon the heart, rendering its beats less frequent, and at the same time increasing their amplitude. These are conditions which may sometimes be exceedingly useful in cases of heart disease, and it is well to bear in mind what you have seen to-day, because in all probability it will be expedient for you to do to your patients what you have seen us do to this animal, and herein, indeed, lies the value of this demonstration. You will most probably in some cases of cardiac disease give digitalis, and you will combine with this, which by itself would contract the arteries, some nitrite of soda, or very likely some spirit of nitrous ether, which will tend to dilate the vessels. In this way you will lessen the arterial tension, while, at the same time, you will slow the pulse and render the beats of the pulse fuller than before. In this animal we are now, after the administration of more of the drug, getting the further action of the digitalis, and the heart is beating rapidly. The vagus is becoming, to a great extent, paralysed.

To show you how potent a factor is peripheral resistance in the regulation of arterial tension, we will now compress the aorta, and you see how the pressure rises; when we relax the aorta the blood pressure falls. The paralysis of the vagus by digitalis is not at all like that produced by nicotine in large doses. Various drugs affect the vagus in different parts. For example, nicotine in large doses acts upon the terminal branches of the vagus in the heart and paralyses them; so that if you irritate the vagus trunk no irritation, however powerful, will slow the heart any more, but the inhibitory apparatus in the heart is not paralysed, and if you try this experiment on the heart of the frog you will find that although the vagus has lost its power over the heart under nicotine, yet the venous sinus has not. When the electrodes are applied to the venous sinus of the heart of a frog poisoned by nicotine it stops just like that of a normal animal; but if atropine be used in place of nicotine it paralyses not merely the ends of the vagus in the heart, but the inhibitory apparatus through which they act. Therefore in a frog poisoned by atropine no stimulation either of the vagus trunk or of the venous sinus will stop the heart.

A diagram of the hypothetical nervous apparatus of the heart that I drew in 1871 may still serve to illustrate this point; nicotine being supposed to act on A and atropine on I.

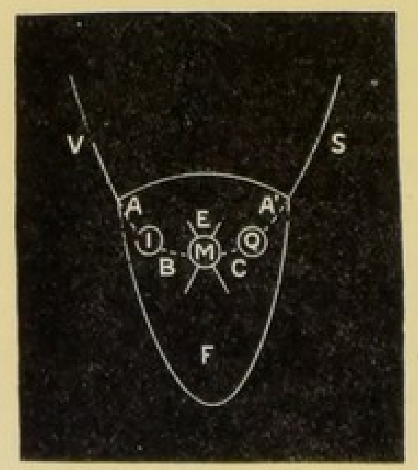

FIG. 107.—Diagram to illustrate Schmiedeberg's hypothesis of the nervous apparatus of the heart. F, cardiac muscle; M, motor ganglia; I, inhibitory ganglia; Q, quickening ganglia; A, A', B, C, intermediate apparatus; V, vagus; S, sympathetic.

Dr. Tunnicliffe has just suggested that you ought to see the effect of asphyxia. This is produced by turning the stopcock on the cannula which is tied on to the animal's trachea, so that air can no longer enter. You must remember, however, that what we have here is not asphyxia pure and simple, but asphyxia combined with the effect of ether, by which the animal has been so deeply anæsthetised throughout the whole experiment that the functions of the sensory centres have been completely abolished, and no sensory stimulus, however strong, could produce the slightest sensation. You saw that, although the digitalis affected the heart and vessels, not the slightest movement of the animal occurred. The phenomena of asphyxia, which we shall be able to show you, though only in a modified form, depend upon the irritation of certain nervous centres by asphyxial blood. Ether has, however, diminished the excitability of these centres, even the lowest ones, so that the train of events, you will observe, will be to some extent modified.

The first effect, as you see, is a slowing of the heart and a great increase in the amplitude of its beats, along with a marked rise in blood pressure. As long as the rise of pressure is maintained the animal can be brought round with comparative ease. But now, you see, the heart-beats are getting slower and slower, and the blood pressure is falling. This fall will continue until the heart is exhausted. Here, too, the exhaustion is not the consequence of want of material to supply the energy for contraction; it is due to poisoning of the heart by the accumulation of waste products.

Atheroma.—Now, all the drugs which are used for the relief of pain in angina pectoris are merely palliatives. They ease the symptoms, they lessen the pain for the time being, but they do not prevent its return. The drug that prevents the return of pain, I think, more than almost any other in cases of angina pectoris is iodide of potassium in large doses. It may seem a very odd thing that this should be. Practically we cannot tell the reason why with certainty, but there is this to be said: that in a great many, and probably in most, cases of angina pectoris we have an affection of the vessels, and more especially of the coronary vessels of the heart, of a nature allied to the changes which take place in rheumatic joints. The vessels become harder, more brittle, their lumen is lessened (Fig. 108),

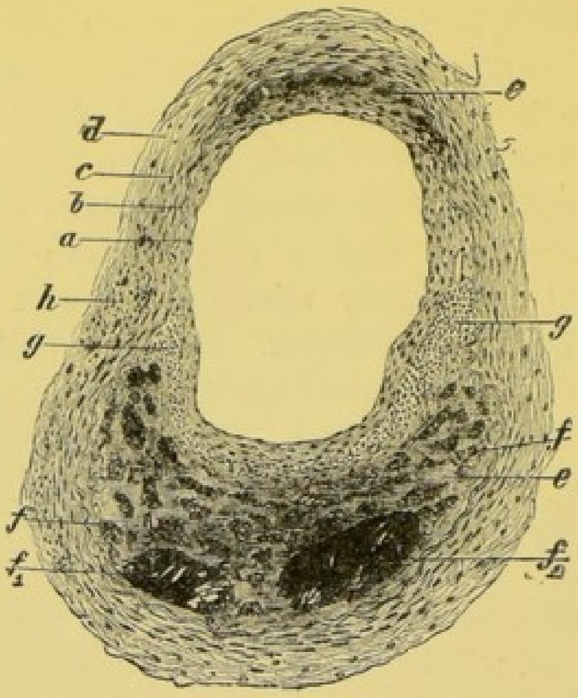

FIG. 108.—Section of an atheromatous cerebral artery. *a*, intima considerably thickened; *b*, bounding elastic lamella of intima; *c*, media; *d*, adventitia; *e*, necrosed denucleated tissue with masses of fatty detritus; *f* and f_1, detritus with cholesterin tablets; *g*, infiltrated leucocytes in the intima; *h*, infiltrated leucocytes in the adventitia. (After Ziegler.)

and they do not yield to any demand for an increased supply of blood in the same way that the healthy vessels ought to do. Whenever the healthy vessels are called upon to carry more blood to an organ in order to meet the demands of increased functional activity in a young, strong man they dilate, and so every organ in a young man is able, like the young man himself, to make a spurt when called upon to do it; but as the individual becomes older not only do the joints get less supple, but his arteries get less elastic, and when any organ is called upon for a spurt it does not receive an appropriate amount of blood, as the organ of a young man would. Most of you know that in cases of thickened, hardened joints you often get a great deal of relief from the administration of iodide of potassium, and probably the effect of iodide of potassium on the arteries in atheroma is the same as in the joints. Atheroma has generally been looked upon as a disease for which there was no cure, and there is no doubt whatever that atheroma is a condition which, if it is to be cured at all, must be cured only by long-continued, patient, careful treatment. But I believe it can be cured, just like pain and stiffening in the joints. You cannot always remove, but you can frequently relieve, the stiffness in rheumatic joints. I was very much struck some time ago by a patient who told me that his thumbs had been affected with rheumatism, or so-called rheumatic gout, so that the joints became stiff, and it was utterly impossible for him to hold a pen. This condition lasted for no less than a year, and it was most inconvenient for him, because he was a lawyer in large practice. The consequence of long-continued treatment, lasting for a year, however, was that the thumbs became again movable, so that he was able when I saw him to hold a pen quite readily. This was to me a great lesson, because, if one can find such changes occurring in stiffened joints, there seems to be no reason why one should not get similar changes in stiffened arteries, and, indeed, I believe I have seen changes of this sort occur in arteries.

Three years ago I saw a lady who was then apparently suffering from senile dementia. My diagnosis was that the vessels of her brain were thickened and atheromatous, that the functions of the brain were suffering in consequence of diminished supply of blood; and my prognosis was that she would get steadily worse, and there was nothing whatever that was likely to do her good. I saw her again after two years, and I still believe in the correctness of my diagnosis, but I found my prognosis was quite wrong. Instead of getting worse, she was better, but then I discovered that she had been subjected for the whole two years to treatment for rheumatic joints. The joints were ankylosed, and did not improve under baths and massage, but the treatment which had been uselessly applied to the joints had benefited the brain.

I do not know whether I mentioned to you that every organ in the body requires that the arteries which supply it shall themselves receive constantly fresh supplies of nutriment, and shall have their waste products constantly removed. Nature has provided an apparatus for supplying these needs both in arteries and muscles, and perhaps we may understand its mechanism best by considering first what occurs in muscles. A is a muscle, B the vessels branching into it; around this we have a hard fascia. As the muscle contracts it becomes thicker, presses against the fascia, and drives out of the lymph space, which lies between the muscle and fascia, any fluid that may be present in it (Fig. 109). It drives the fluid on into the

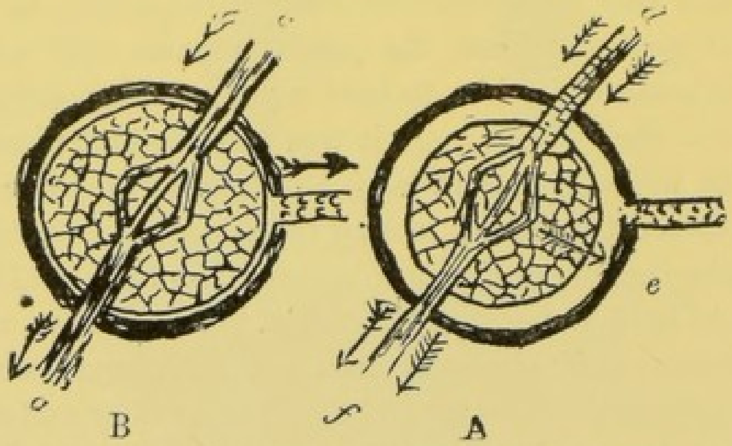

FIG. 109.—Diagram of transverse section of voluntary muscle to show the pumping action exerted on the muscle, juice, and waste products during action. The blood-vessels cross diagonally. To the left (B) the muscle is contracted, and presses the two layers of the fascia together so as to drive the muscle juice out into the lymphatics; to the right (A) the muscle is relaxed and tends to draw the layers of fascia apart and suck the juice out of the muscle into the lymph space. *c*, artery; *d*, artery; *e*, lymphatics; *f*, vein; *g*, vein. The double arrows in A are intended to indicate the increased blood flow through the muscle, and the single arrow within the muscle to indicate the passage of fluid from the muscle into the lymph space between it and the surrounding fascia.

lymphatics, C, and there is a provision that the smallest quantity of fluid driven into the lymphatics shall not get back again, for in them valves occur at such short intervals that even a very small amount of fluid is caught, and not allowed to return. When the muscle relaxes it tends to cause a vacuum between the muscle itself and the fascia which surrounds it, and thus the lymph from the muscular substance tends to be sucked out of the muscle into the lymph space. Thus the contractions of the muscle are, like a combined suction and force pump, constantly sucking the juices from the muscle and forcing them onward into the lymphatics, and the more the muscle acts the more rapidly are fresh supplies of lymph yielded to it by the blood, and the more rapidly is the lymph pumped away from it into the lymphatics. In a similar way we have a provision in the walls of the arteries themselves for removal of waste (Fig. 110). Around the artery we have a stiff, unyielding, fibrous sheath, in which the vessels run. Each time the heart contracts the arteries become dilated by the blood driven into them, they encroach on the space between their walls and the sheath, and the fluid is driven out from the adventitia surrounding them into the lymphatics. During the cardiac diastole, when the artery returns to its former calibre, a vacuum tends to be formed between it and the sheath, and thus lymph is sucked up from the adventitia, and so we have the same process going on in the arteries as we have in the muscles (Fig. 110).

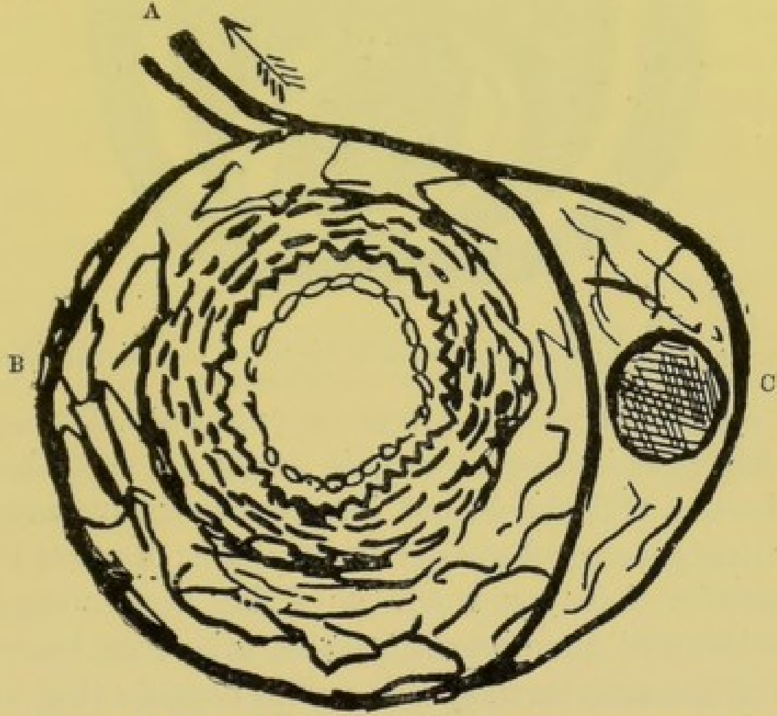

FIG. 110.—Diagram of artery and nerve in a sheath of connective tissue. A, lymphatics; B, sheath; C, nerve.

In the heart itself there is also a mechanism by which the waste products can be removed from it, and this, as well as

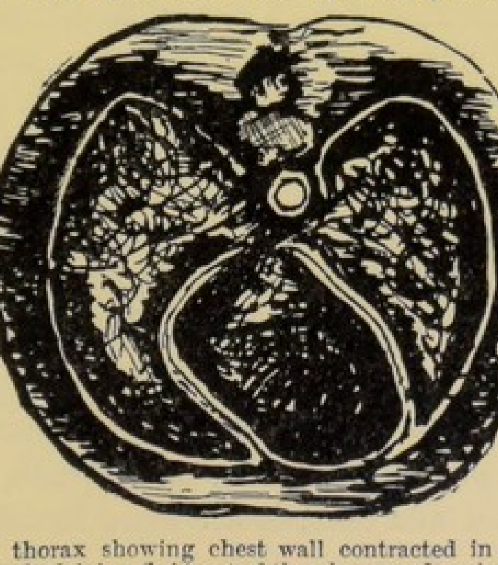

FIG. 111.—Section of thorax showing chest wall contracted in expiration, and heart in diastole driving fluid out of the pleura and pericardium.

that in the arteries, is set in action by the mere pulsations of the heart (Figs. 111 and 112). You can readily see that if you

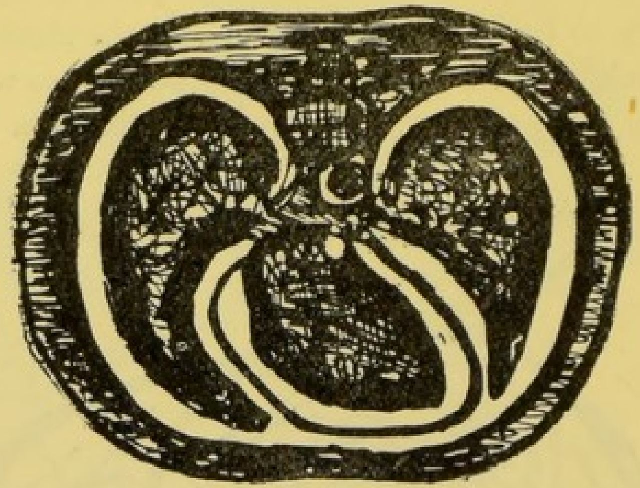

FIG. 112.—Section of thorax showing chest wall in inspiration and heart in systole sucking fluid into the pleura and pericardium.

have got a case of a man in whom the pulsations of the arteries are very slight, as in cases of chronic Bright's disease, the pumping mechanism will not be put into very extensive action, and you may thus get a much greater accumulation of waste products in the arteries than you would do if his heart were beating more forcibly and there were a greater difference between the diameter of the arteries in systole and in diastole (Fig. 113).

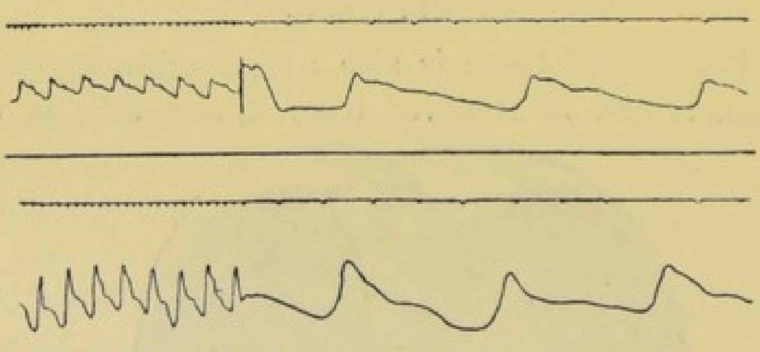

FIG. 113.—Pulse tracing showing the effect of a three months' course of massage and graduated movements. Each tracing is taken partly with a slow and partly with a quick movement of the sphygmograph. The upper shows high tension and a feeble heart; the lower shows less tension and a stronger heart. These tracings I owe to the kindness of Dr. Gustav Hamel, to whose treatment I had recommended the patient.

Now you know that during exercise the heart beats more forcibly, and if you put your finger upon the pulse, the differences between the systole and diastole are more readily felt; that is to say, you have a fuller pulse after exercise than during complete rest.

Effect of Exercise.—You know that if men have been unaccustomed to exercise for a length of time they get "out of training," as it is termed, so that if they try to run even fifty yards they may become quite breathless, and at the end of the race they may gasp and feel as though they were going to faint. This is not due to any paralysis of the heart, but simply to what is termed weakness of the heart, the cardiac muscle, like the muscles of the body, becoming weaker from want of exercise. When any muscle is imperfectly exercised, whether it be cardiac or skeletal, it appears to become unable to get rid of the products of its waste so rapidly as when it is in training, and perhaps these products may be formed more quickly and in larger quantities. The waste products cause fatigue and loss of contractile power in the muscle, and consequently it becomes weaker and more easily fatigued. Now in cases where we have to deal with hearts which are feeble in consequence of disease the best method of restoring the patients to health is to follow the plan commonly employed by persons who are going to perform athletic feats, viz., that of *training the heart.* Recently this plan of training has come very much into vogue, and one hears of it almost every day. The best example of training that I know is the old classical story, which you have read in your school-days, of Milo, the wrestler of Croton, who succeeded in carrying a full-grown bull upon his shoulders by the simple plan of beginning with a new-born calf, and carrying it every day. He never noticed—so the story runs—the gradual increase of weight, but carried it quite comfortably day by day until it became a full-grown bull, when still he carried it with ease. This story illustrates the principle of training better than anything else I know. What you want to do is to gradually increase the amount your patients have to do day by day, but so slowly that they do not feel it.

LECTURE 19.

Exercise, *continued*—Massage—Resistance exercises—Saline and effervescing baths—Effect of Nauheim treatment—Oertel's treatment—Atheroma—Aix massage—Dry air bath—Counter-irritation—Depletion—Leeches—Cupping—Precautions in applying leeches—Digestion—Action of drugs on the teeth—Toothache.

Gentlemen,

At the end of last lecture I was telling you of the use of exercise; that is, of training the heart as well as of training the voluntary muscles. I gave you the example of Milo the wrestler, as told in the classical story, who was able to carry a full-grown bull upon his shoulders by beginning with a new-born calf and carrying it every day until it became a bull, so that the increase took place so gradually that it was imperceptible. This is, I think, the best example that I know of thorough training. It is the "little more" every day that tells in the end, and if you put on too much on any one day it is upon the whole rather a loss than a gain; for it may cause overstrain, so that you may be forced to turn back and begin at an earlier stage again instead of going steadily forward to increased strength. Now, exercise is one of the things that people as a rule recommend to their friends. You will often hear folk say, "If So-and-so would only take a little more exercise, walk out in the open air, and bestir himself generally, he would be so much better." In many cases this is quite true, but there are a lot of people who are too stout to take exercise, and there are some with hearts too feeble to allow them to take exercise. When you get cases of this sort, what is to be done? The patients are steadily getting worse and worse for want of the exercise, and yet they are quite unable to take it.

Massage.—Now, both in cases of excessive stoutness where the weight carried by the patient is too great for his muscles, and in cases of heart disease where the exercise is too great a strain upon the heart, you can supply the place of exercise by massage. This has the power of inducing the same changes in the muscles that are brought about by exercise (Fig. 114);

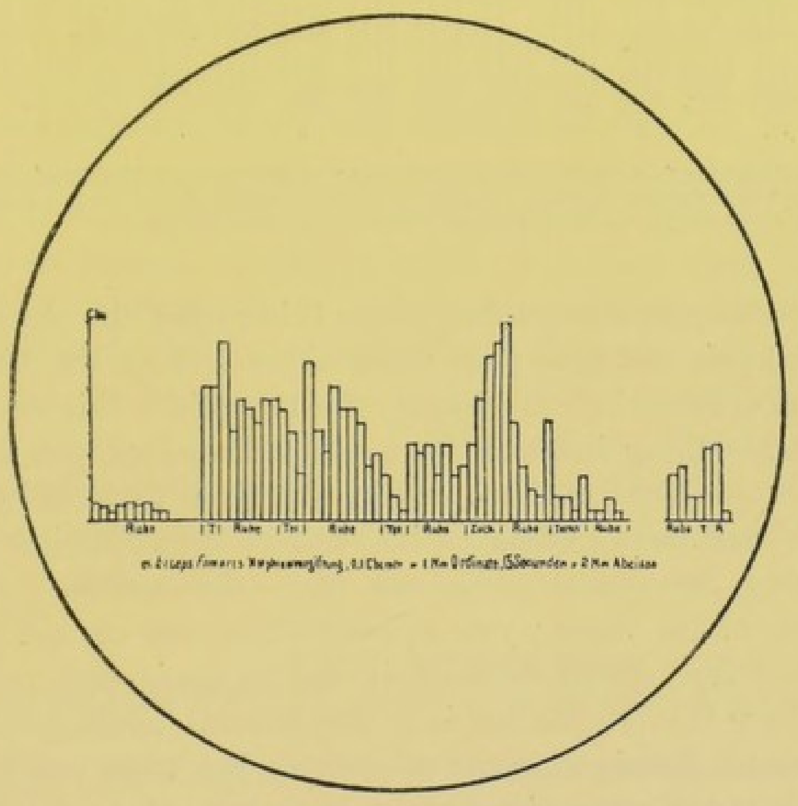

FIG. 114.—The marks along the base line indicate seconds; the height above the base line indicates the amount of blood flowing from the veins of the biceps of a dog during tetanus (T or Tet), during rest (*Ruhe*), or during simple contraction (*Zuck*). (After Ludwig and Sadler.)

that is to say, massage greatly increases the flow of blood to the muscles, and greatly assists the removal of the waste products. Massage increases the supply of blood to a muscle enormously, so that in a muscle which has been rubbed the amount of blood which flows through it may become trebled (Fig. 115). It may not seem a great deal to say that three times as much blood flows through a muscle in a given time after massage as before; but when you see the actual experiment it does strike you very forcibly. For example, supposing you have a tube which is connected by a cannula with the muscle, and the blood flows out through the tube. Let us say that in one minute before the massage the blood flows out at a rate

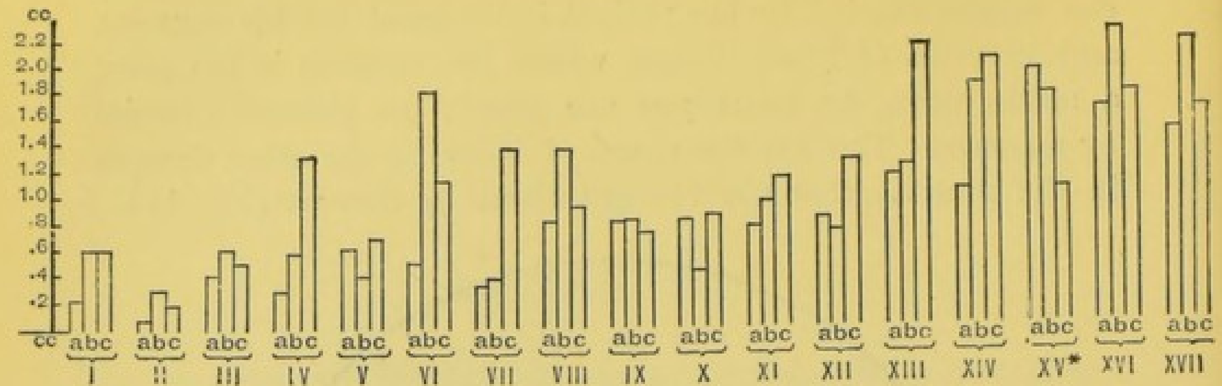

FIG. 115.—Diagram to show the effect of massage on the flow of blood through muscle. *a*, shows the amount of blood in cubic centimetres which flowed from a muscular vein when it was simply opened; *b*, during massage; *c*, after massage.

sufficient to pass along a foot of the tube; after the massage, in one minute it will have gone along three feet of the tube, and when one sees the experiment one recognises this as a very remarkable thing indeed. By massage, therefore, you increase the flow of blood to the muscle, and you thus bring fresh material and fresh oxygen to it. But at the same time you do something more, you press out from the muscle itself the products of its waste; you squeeze these out of the muscle into the lymph spaces between it and its fascia, and you press them along the lymphatics into the general circulation. You can thus see that in massage of muscles you want two kinds of movements. You require first of all a kneading or squeezing movement to press the fluid out of the muscle itself into the sheath, and then a rubbing movement from the periphery towards the centre, in order to press the lymph, which has already reached the lymphatics, into the general circulation. By the use of massage you can supply the effect of exercise in those too weak to take it, and this is the reason why massage has come into such general use. It was to a great extent introduced into England through America by Weir Mitchell, who wanted to increase the nutrition of many of his patients. In the Eastern States of America, there are a great number of highly nervous people who live at a very quick pace and wear out their nerves sooner than they can repair them. In order to repair the waste, Weir Mitchell put them to bed with perfect rest; but then they lost their appetites. You will find that many patients object to being put to bed, for the reason that they say "it is very weakening." This is quite true; they do get weak because they cannot eat so much, and their muscles fail for lack of exercise. If, however, you put them to bed and give them massage, they get an appetite just as if they were going about, and there is not the same amount of wasting of the muscles or nerves, while a large amount of repair takes place in them. Thus, massage comes to be one of the most useful therapeutic measures we have at our command.

Now there is probably no instrument that is powerful for good which is not also powerful for evil. Alcohol is one of the best things we have in medicine; opium is perhaps even better, but both of these drugs are liable to the utmost abuse, and, like them, massage is also liable to great abuse. Still, the use of massage is one of the greatest boons we have added to medicine in the last quarter of a century. With massage, when properly applied along with absolute rest, we can bring round cases of cardiac disease that seem almost hopeless. In cases where the heart is failing, where it is not like those of Longfellow's poem—

> "And our hearts, though stout and brave,
> "Still, like muffled drums, are beating funeral marches to the grave."

But where every beat seems to bring the patient not in a slow march but in a gallop towards his grave, then we find that by letting the patient remain absolutely still in bed, the heart begins to recover its power; but in order to prevent the weakness which might otherwise come on, as well as to aid the heart in its action, we find massage useful. You can readily see how this would be; because, as I mentioned to you before, the action of the heart is to pump the blood from the venous into the arterial system, and if by means of massage you help the venous blood onwards from the periphery to the centre, you are doing a great deal of the work of the heart: you are easing it to a great extent, and the heart is correspondingly benefited.

It is very hard indeed to make patients understand what you mean by "absolute rest." They will get up, they will move about, and very often will go to the closet. Now the absolute rest, which is sometimes so useful, means that they should remain in bed and get up on no account whatever; that they should be content to be fed, to be moved, to remain absolutely passive in the hands of the nurses. If you can induce them to do this, you will really, I think, be perfectly astounded at the results you may obtain in some cases of heart disease. The cases in which you get the best results are, I think, those of mitral disease, either regurgitation or obstruction, or both combined.

There is a little point which you might hardly think of in regard to treatment, and that is the nature of the bed on which the patients lie. It does not do to have it too hard, otherwise it is uncomfortable, but if it is too soft it does not give them sufficient support; they do not rest so well, and they do not recover so quickly. I was once called to see a case in the country; a man suffering from severe mitral disease. He was unable to sleep or rest, and I found that he was lying upon a feather bed, which was laid upon the top of a hair mattress. I just asked them to alter the position of this by putting the hair mattress over the feather bed, so as to give him more support. This was done, and he slept with perfect comfort through the night, whereas he had been previously obliged to sit up night after night. The hair mattress lying over the feather bed was quite sufficiently soft to prevent his feeling any discomfort, and just gave him enough resistance to make him comfortable and to prevent him slipping about.

Resistance Exercises.—After your patient has so far recovered, you must employ something more than mere rest and massage; you need to train the heart a little more, and you do this by giving a little graduated exercise. Graduated exercise may be given by the patient himself or by an attendant. If I raise my arms quickly and let them fall at once, I only put into action the elevators of the arm, but if I raise my arm slowly and allow it to fall slowly, all the time that the arm is moving two sets of muscles are in action, viz., the elevators and the depressors of the arm. By increasing the resistance which these offer to one another, you can yourselves put a great deal of muscular energy into a very slight movement indeed; so that patients may use resistance movements by themselves. But it is sometimes difficult to teach patients to do this. All that you can often do is to tell them that they must do the movements very slowly. Sometimes you can train them to throw much muscular energy into these slow movements by putting the opposing muscles into action at the same time, but it is easier, as a rule, when you wish to get the degrees of resistance carefully graduated to apply the resistance from the outside. This is done by an attendant who gently resists every movement that the patient makes. These movements were studied and worked out in Sweden, more especially by Ling, but they were not much used until they were taken up by the Brothers Schott, of Nauheim, and they have been worked by them along with baths into a regular system of treatment, which is often known as the Schott System or the Nauheim System of treatment.

Saline Baths.—In addition to the movements, the Brothers Schott have used baths, first of all saline, and then saline with the addition of carbonic acid. These baths apply a stimulus to the skin, and through the skin they apparently act reflexly upon the heart and vessels: slowing the heart and rendering the circulation quieter than before. The movements employed by them are very simple. I went over to Nauheim a couple of years ago and Dr. Schott kindly allowed one of his best masseurs to come to me and put me through all the movements. As each movement was finished I jotted it down and have had a list printed, which you can have at the end of lecture. The first movement we have is gently to raise the arm slowly out from the side; we put on a very slight resistance, and when the arms are horizontal we give the patient a rest; in fact, a rest is allowed after each movement. The next movement is that the body is inclined sideways as much as possible to the right and then to the left, with the hand placed on the hip. I show you the general method and you can follow out the other movements from the list. The movements need not be carried out necessarily in the order in which I have placed them; they may be sometimes varied with advantage.

Under the influence of the baths and of the movements you get extraordinary results. I was a good deal astonished a little while ago when I recommended a patient to go to Nauheim, to receive a letter from the general practitioner who had been in attendance upon him, saying that the Nauheim treatment was too new to enable him to form any opinion about it, that he did not think it was any good, and, therefore, he advised the patient not to go. The man in question simply knew absolutely nothing about it: he had not taken the trouble to enquire, and so he decided upon a basis of pure ignorance.

It is often better to take a single test case and work that out thoroughly than to take a number of cases and work them out imperfectly. I took one test case, which I sent to Nauheim, which I saw there when I went over afterwards, and which I have watched since. This patient was a medical man, an old fellow student of mine; he had been in India for a number of years; his heart had failed; he had mitral regurgitation, an enormously dilated heart; his legs were swelling; his breath was short, and he seemed as if he had not more than three or four months to live. I tried digitalis, in fact, all the remedies that I could think of, and still he did not improve; so I advised him to go to Nauheim. He went there, and when I saw him there his heart had distinctly diminished, the dilatation was very much less than before (Fig. 116). He

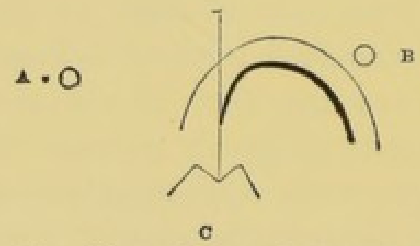

FIG. 116.—Diagram of the cardiac dulness before and after a bath. A similar effect is produced by gymnastic exercises. The thin line shows the graduated dulness before and the thick one after; A, nipple; B, nipple; C, ensiform cartilage.

continued there a good while after I left, but I saw him on his return, and I found that the improvement had continued. It went on after he came back to such an extent that he was able to return to India that winter and resume his work. I heard no more about him from himself for some time. As a rule you do not find that patients who are greatly benefited tell the doctor anything about it; but I heard from another friend of mine who was the chief medical officer in an enormous district in

India, having many millions of people under his medical charge. He came to England, and while he was away on leave, my friend with the damaged heart applied for his post; so that showed that the treatment he had had at Nauheim had considerably improved his heart, because at the time he left for India he was hardly able to get upstairs.

But even the Nauheim treatment is not all that you want; it is only part of a general method of training. The Nauheim treatment does splendidly for a particular class of cases, but it will not do for cases that are too bad to move. For these you want absolute rest and massage. Further, just as it is too much for cases that are very bad, it is not enough for some mild cases.

After the Nauheim treatment, comes in another method, which has sometimes also been overdone and has got into disrepute. This is the method of training by gradual exercise, not against definite resistance, but against weight, viz., by lifting the body. That is to say, the patient walks up an incline which the first day is very, very gentle, next day steeper, next day steeper again, and so on, until he is able to walk without difficulty up pretty steep inclines. This method is known as Oertel's method.

We have, then, the following three methods of treating heart disease, according to its severity:—

1. Massage and rest.
2. Schott's treatment.
3. Oertel's method.

The essence of Oertel's method is the gradual increase in the work thrown on the heart by walking up an incline which becomes gradually steeper and steeper. Like Schott's method, it consists in graduated exercise, but along with this Oertel generally combines the direction to abstain, as far as possible, from liquids, and to take dry food. This, I think, is probably to a certain extent an advantage, because it tends to prevent, for one thing, the accumulation of flatus in the intestine and in the stomach—an accumulation which so hampers the action of the heart. As I said before, when the heart and circulation are imperfect, the absorption of gas from the stomach and intestines goes on slowly. You have, therefore, a tendency to accumulation of gas in the stomach and intestines, and this gas presses up the diaphragm. I show you a diagram of the heart and stomach in the normal position, indicated by continuous lines, and with their position, when the stomach is distended by

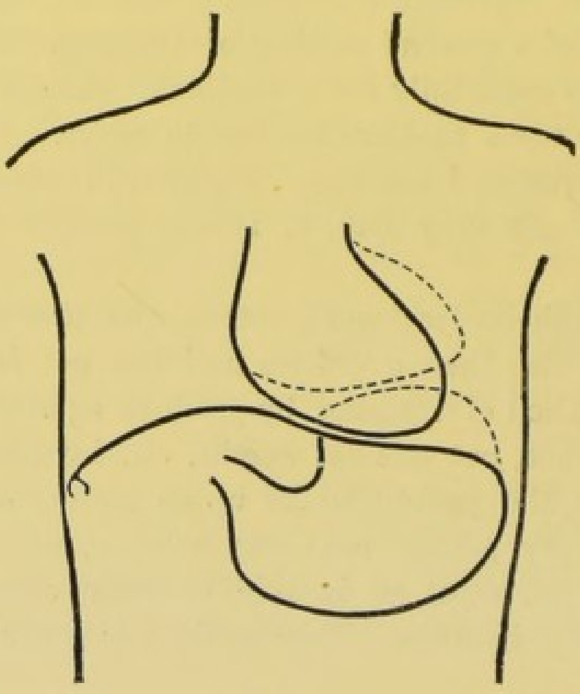

FIG. 117.

flatus, indicated by dotted lines (Fig. 117). There is nothing between the stomach and the heart excepting the diaphragm. When the stomach becomes dilated, it naturally pushes the diaphragm up, displaces the heart, and the heart becomes embarrassed in its action. So that frequently a patient may almost faint simply through the functional disturbance of the heart produced by flatus, but directly the flatus passes away from the stomach the heart resumes its function again, and the patient feels better.

I mentioned to you before that one of the diseases that is very liable to come on in persons over middle age is atheroma, a condition of hardening of the vessels which resembles hardening of the joints in its pathological nature. This condition of the vessels, when it affects the coronary artery, is very likely to lead to angina pectoris by weakening the heart from lessening of its nutrition. It may also lead to a large number of other accidents, because the atheromatous material may become dislodged from the vessels and may pass to the brain or to other organs (Figs. 4 and 118). According to the part of the brain to

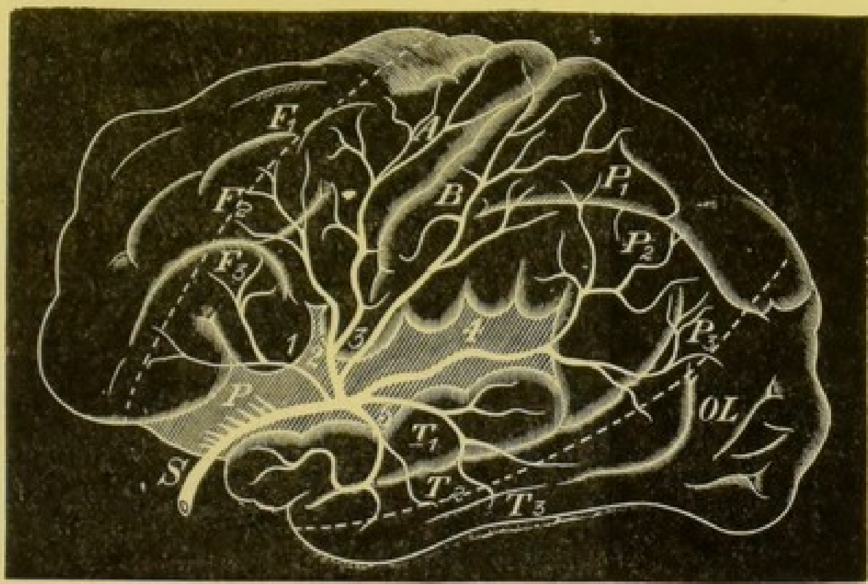

FIG. 118.—After Ross. Distribution of the arteries in the brain.

which the atheromatous plug goes, we may get various symptoms affecting the motor powers, the sensory powers, or the thinking powers. One man may have a little weakness in his hand or limbs, another may have a feeling of numbness in some part of the body, while another may lose some little mental faculty; or, as we say, may be weak in his brain (Fig. 119). One very curious case of this sort that I once noticed was that of a man who was doing a big business in the City. One day he had a little tendency to drowsiness, and did not feel well. He was obliged to stay away from his work, and when he went back he could do everything excepting one: he was unable to fill in the figures in a cheque. He could write the cheque all right, he could write the numbers, but he could not put the figures in. Shortly afterwards he had another drowsy fit, and these continued to recur at intervals, each one leaving him a little lower in his mental condition than before, until he had to give up business. Then he retired to a house in one of the suburbs, little by little his mind failed him, and lastly he died.

Atheroma is a disease that one, I think, can lessen to a considerable extent by the use of exercise. You will often hear people saying that exercise makes them feel so much younger again, and there are a number of men, especially in the City

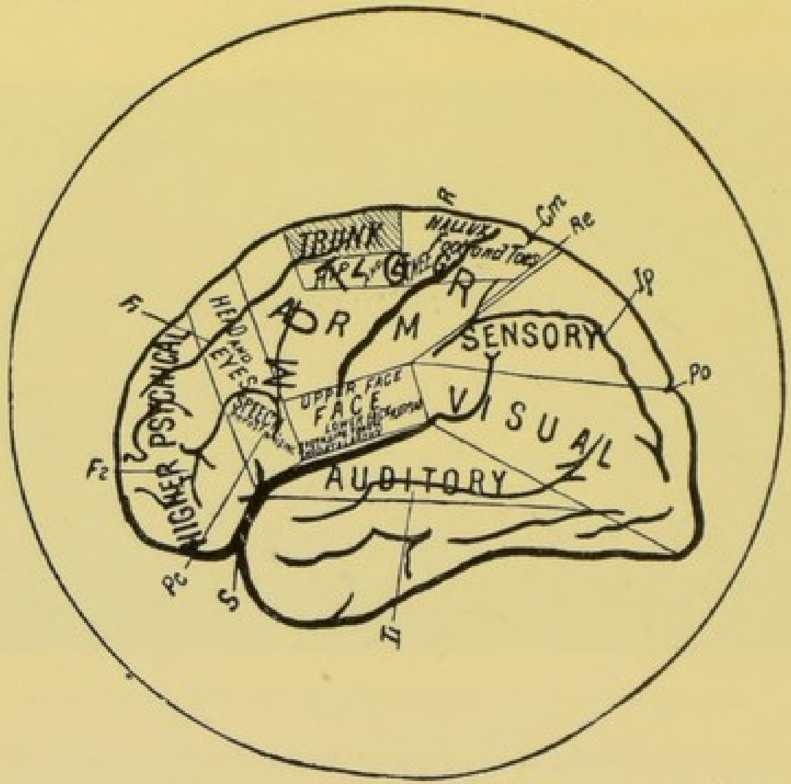

FIG. 119 Cerebral cortex showing the distribution of function. After Osler.

who are busy, whose time is very valuable, and they cannot afford, they say, to give up much time. They will not, as a rule, take exercise in the form of enjoyment: they look upon that as a waste of time, but if you get them to take exercise under your prescription, to take it as a means of getting well, and not for enjoyment, they will do it. Accordingly for some time past, instead of recommending men, as I used to do, to take a ride in the Park, or to go in for some sort of exercise in the morning, I advise them to take a course of Swedish movements. If these City men can get the movements for about half an hour on their way down to business, it very often repays them well; they feel so much brighter during the day that they more than make up for the loss of half an hour in the morning. They can put in an hour's extra work in the day, whereas it has taken them only half an hour to do the movements; and many of them, I find, will do this when they would simply raise all sorts of objections to getting a horse and riding round the Park, though there is very little doubt that if a man will ride a horse it is one of the very best forms of exercise. The question is very often put to you by patients with cardiac disease, "May I ride or not?" Well, the answer to that depends very much on the severity of the disease, but often you may say, "You may ride, provided you do not go in for big jumps or ride a pulling or jumping horse."

Any string, however frail, stands a steady strain pretty well. If you want to break a string, it is not by pulling steadily that you do it; it is by a jerk, and it is a jerk, much more than a steady strain, that tends to break the arteries. A man may walk five-and-twenty miles a day with no damage whatever when it might kill him to run fifty yards to catch an omnibus. Thus, in cases of cardiac disease, it is well to warn the patients against sudden jerks, and to allow them to go in for steady movements.

This question of the treatment of atheroma I have discussed fully in a paper, of which each of you can have a copy after this lecture, so I need not go into it any more in detail now.

We now come to the local increase of blood in various parts, and this we effect partly by massage, which, as you will soon see if you rub your hand for awhile, leaves the vessels somewhat dilated, increases the supply of blood to the part, and thus causes increased nourishment to the part. It is thus not only useful for the general nutrition of the body, but it increases the nutrition of the muscles when these are wasted, and it increases the circulation through joints and causes absorption to take place more readily when they are thickened or swollen, so that massage is exceedingly valuable in cases of chronic disease of the joints. There is a method of massage which has lately come into vogue, and which appears to be very useful. It is known by the name of the "Aix" massage, because they use it at Aix-les-Bains very much. It consists in the masseur having a little tube fastened to his hand, and through this tube water is flowing under pressure. The water may be either plain salt water or sulphur water, and while he works the joint water flows over it, so that it is subjected at the same time to a continuous douche and to the movements of the masseur's fingers.

I believe that the application of liniments is another form of massage. No doubt the liniments have some action of their own in stimulating the skin, but I do not believe it is so much *what* you rub in as *how* you rub it in, because all sorts of liniments answer. Elliman's Embrocation, St. Jacob's Oil, and others are famous for their effect in healing joints, but I do not know that they are a bit better than the liniments we have in the Pharmacopœia, *e.g.*, the linimentum potassi iodidi cum sapone, the linimentum terebinthinæ aceticum, and the linimentum saponis. These are all exceedingly good if they are well rubbed in, and I believe it is the rubbing which has a great deal to do with their useful effect upon the joints, though many people who would scorn massage believe implicitly in the efficacy of liniments.

Dry Air Bath.—I have seen another method lately which appears to be really useful. It consists of the application of great, but dry, heat to the joints. The joint is put into a copper chamber, in which the air is heated up to about 180° F. or more, and after the joint has been a little while in the chamber it becomes more flexible. It is then moved about a little. After the joint has been taken out it becomes stiffer again in a short time, but not so stiff as before the application of the hot air bath; and by keeping up this treatment for several months the joints gradually become fairly flexible. Some of you may have seen a case we had a few months ago in Rahere Ward, where a man was sent in because his joints were so stiff that he was quite unable to hold a tool, and he was thus deprived of every opportunity of earning a livelihood. The joints of his fingers were so fixed that the hand was almost open, only the last phalanges of the fingers being flexed; but by the application of the hot air we succeeded in about three months in enabling the man to close his hand quite sufficiently to grasp a tool.

Counter-Irritants.—Another method of altering the local distribution of blood is by counter-irritants, *e.g.*, by blisters, or, what is sometimes still more effectual, the actual cautery. The actual cautery is used largely in veterinary surgery, as diseases of the joints in horses are both frequent and important. Where the joints are stiff the actual cautery is very often applied, and with great success. As a rule we are more inclined to use liniments, or mustard leaves, or blisters in man, and the application of a blister to a joint frequently seems to render the supply of blood much freer and the recovery much more rapid. Some years ago I saw a very striking instance of this in the casualty department. A workman came with his hand quite swollen and stiff. He was unable to work at all because the fingers were so stiff; he could not close his hand, and it was at the same time painful. I painted the back of the hand with tincture of iodine. It did not do any good, and he went on for two or three weeks without any improvement. At last I said to him: "You must paint more on." The next time he came back he had been painting very vigorously indeed. The hand was swelled up to twice its normal size, and I said: "You have overdone it now;" but he had not overdone it. He had just done the right thing, and a few days afterwards the blebs of the blisters disappeared, and with them the whole of the swelling, and to a great extent the stiffness also, so that the man was able to go back to work quite comfortably. I think very frequently we do not get the improvement we ought to from counter-irritation from not applying it sufficiently strongly. Of course there is always a tendency to overdo it, and one is afraid of using counter-irritants to such an extent as to cause very severe suffering to the patient. The patient, in the case I have described, did this to himself, but I should not have thought of doing it myself so severely; he had pushed it a great deal farther than I should have really dared to do. I should not have thought myself justified in applying the blister to the same extent as he had done, and yet by stopping short I should have probably failed in easing the joint.

Depletion.—There is another method by which we can alter the distribution of blood, and that is by depletion. We can lessen the supply of blood to a part by the local application of cold, and in cases where the pain appears to depend upon an excessive amount of blood in the part, the application of cold frequently gives relief. We use it more especially in cases where the inflammation is under or in an unyielding structure, for example, inflammation in the periosteum, under a fascia, or in any part where pus is forming, and which cannot swell, as, for instance, in a whitlow, or in the alveolus of a tooth. Then we may remove blood locally by means either of leeches or cupping.

We may alter the distribution of the blood without actually removing any by means of dry cupping, and this is a method of treatment that is sometimes of the greatest possible use, more especially in cases of bronchitis, in cases of œdema at the base of the lungs, and in cases of disease of the kidneys. The easiest way is not to employ the exhausting syringe, which was formerly used, but simply to use a little spirit with a wine-glass or tumbler. You put a few drops of spirit on a bit of blotting-paper, and then place this inside the glass; next you turn it upside down to see that no spirit runs out. It is very necessary to take this last precaution, because if there is too much spirit some of it is apt to run out of the glass along the skin and, taking fire, to burn the skin. You then set a light to the blotting-paper, and when the tumbler, glass, or cup has become fairly hot you put it on the skin firmly, and, as you see, the air being exhausted, the skin rises into the cupping glass in the form of a small rounded swelling. As you watch this, you find that the skin becomes more and more congested, until at last it generally turns a dark red colour. The way to take the glass off is not to pull it off sharply, as that hurts the patient, but you just put your finger at the edge of it and let a little air in, and the cup falls off by itself.

In cases where you wish to draw blood, you use the scarificator. This consists of a large number of lancet-shaped blades which are concealed within a case. I show you one containing a dozen blades. By turning the screw at the back these blades can be made to project more or less from the surface of the case. If you wish to cut deeply, then you push the blades further out; if you wish to cut only superficially, then you draw them further in. The blades are set by a trigger; and when they are released by pressure they shoot forward, describe a circle, and cut through the skin. The movement is so quick that it is hardly felt by the patient, and you will not be able to see it unless I press a piece of paper against the blades. The cuts are generally about half an inch long. When the skin has been scarified in this way you apply the cupping glass in the ordinary manner, and leave it on until you have got as much blood as you want. Sometimes the cuts become closed by coagula, and then you simply take the cupping glass off, pass a sponge over the skin, and put the glass on again.

In place of the scarificator and the cupping glass you may use leeches, and these are simply applied to the skin and allowed to settle. You do not want them to move all over the skin, as they have a way of doing, so usually you put the leech either under a wine-glass or under a pill-box, and put it on to the place upon which you wish it to settle, and by-and-by it takes hold and draws blood. But leeches are sometimes rather fastidious and will not take hold, so that in cases where this occurs you wash the skin with soap and water first, and then with clean water to take away the soap, afterwards dry it, and the leech will then possibly fasten. If it does not fasten, you may try the effect of a little cream, and if that fails, you can then just prick the finger with a needle, take a drop of blood, and smear it over the surface, and this sometimes induces the leech to fasten. Sometimes tobacco smoke in a room or any very strong smell of any kind tends to prevent leeches from fastening; so that one avoids anything of that sort when one wishes to get them to fasten. If you wish to apply the leeches over a perfectly definite spot, you may do it by simply cutting small holes in a bit of paper, and putting this on the skin just over the place where the leeches are intended to bite. Then place the leeches on the paper and cover them with a glass. They can thus only bite through the holes.

Sometimes, however, you cannot apply them even in this way. You may want to apply them to some place where they must bite precisely at the point that you desire, and where they must not be allowed to wander at all. For example, occasionally one wishes to draw blood from the tonsils. The leech is put into a kind of small syringe with its head toward the nozzle, and the piston is gradually pushed forward, until the head of the leech appears at the point of the syringe, which is then placed upon the spot to which the leech is intended to apply itself. The leech I show you is such a very small one that it is likely to slip right out. It is not only small, but very sluggish, and will not move on. We often find that precisely the opposite occurs, and that leeches go exactly where they are not wanted to go; so that frequently when a leech has been applied to the tonsil it has crawled down the œsophagus, and when it has been applied to the anus it has crawled up the rectum. In a case of that sort what should you do? The rule is to give a large quantity of strong solution of common salt. If the leech has been swallowed, you give this by the mouth, and it causes vomiting, which brings the leech up again; if the leech has passed into the rectum, you give it in the form of an enema, which soon comes away and brings the leech with it. Then there is one other little point about leeches I think that you ought to remember, and that is that the leech-bite leaves a scar which is perfectly indelible, and lasts the whole of the remainder of the patient's life; so that, as a rule, you do not put leeches on to any part of the body where the scar is likely to look ugly. For example, you do not in the case of a lady put them anywhere over the face or neck, arms or shoulders, where they are likely to be seen when she is in evening dress. Another point is that you should not put leeches over any loose tissue. You generally put the leech over a part where you can, if necessary, stop the bleeding by pressure. For instance, in inflammation of the ear you generally put it over the mastoid process, where you have a hard resistent bone, and where you can stop the bleeding if you wish. In inflammation of the eye you do not put the leech under the eyelid, where the tissue is soft, but upon the temple, where you can compress the point.

The amount of blood that a leech takes away is generally about a teaspoonful, but if you allow the wound to bleed for some time afterwards, and encourage the bleeding by a fomentation, you get away two or even three times as much for every leech applied.

In order to stop the bleeding the usual plan is simply to put on a little hard compress; *e.g.*, take a small bit of lint, make it into a little ball, and put it on the leech-bite, and fasten it by a bit of strapping. Such slight pressure is generally sufficient to stop the bleeding. In some cases strong measures appear to be necessary, and perchloride of iron has been used, but since we have learnt the nature of the leech-bite and the reason why it bleeds so much, solutions of calcium salts have been employed. These seem to stop bleeding very well. In cases where the bleeding is very persistent, and does not yield to the ordinary measures, it is usual simply to touch the leech-bite with a bit of nitrate of silver, and if everything else fails—and it just may happen that everything else does fail—you put a needle through the leech-bite and twist a bit of thread round it in the form of a figure 8. As a rule this effectually stops the bleeding.

It is well not to apply leeches, especially to old people and to children, at a time when the patients cannot be carefully watched afterwards; that is to say, if the child cannot be watched during the night, do not put the leeches on just before everybody goes away, because the bites may bleed to an enormous extent, and in the case of a child may seriously drain the system of blood; this may greatly reduce the child's strength, and it may not thus get through the illness from which it would otherwise have recovered.

Digestion.—We may now pass on from the circulation to a consideration of the action of drugs upon the digestive tract, and first of all we have to deal with the action of drugs upon the teeth. This will be brought to your notice, certainly before you have been very long in practice, by your patients, and the ladies will say: "Oh, I cannot take steel drops; they stain the teeth so." "I cannot take acids because they destroy my teeth so." They are quite right; and in cases where you are going to give strong preparations of iron or strong acid mixtures, you allow your patient to suck them through a glass tube; so that the iron or the acid shall not come into actual contact with the teeth. In the case of acids, whether they be employed internally as a medicine, or as a gargle to the throat, it is advisable to tell the patient to use a little tooth powder immediately afterwards: and the teeth may either be brushed with a solution of soda or of bicarbonate of soda, with magnesia, or with chalk tooth powder. The usual thing is carbonate of magnesia or prepared chalk, both of which are very good; and they, or a little bicarbonate of soda, dissolved in water, all tend to preserve the teeth from the effects of the acid. Perhaps there is nothing that destroys teeth so much as acid, and acid is very frequently not taken in the form of medicine or contained in the food, but is actually formed in the crevices of the teeth themselves by the decomposition of food from the action of various microbes in the mouth. This formation of acid tends to make the teeth break away and destroys them.

It does something more, however; it frequently causes a good deal of pain, and not unfrequently pain is induced not in a single tooth, but all round the mouth. The reason of this appears to be that frequently, just round the edges of the teeth the gum recedes a little, and the acid seems to get below the part of the teeth covered by enamel, and to attack the roots of the tooth and cause pain. I think you will often notice that pain all round the teeth, and sometimes not merely toothache, but also headache, depending on irritation in the teeth, may be relieved by simply washing out the mouth with a weak solution of bicarbonate of soda.

The same is the case where there is not merely exposure of the roots of the teeth generally, but a decayed cavity with an exposed nerve. You know from your physiological studies that when you wish to get a quick and well-marked reaction in the leg of a frog you put a drop of acid upon it. If you were to put a drop of caustic potash or soda upon the foot you would probably cause a great deal more destruction of tissue, but you would not cause such a quick reaction. It is the acids rather than the alkalies which cause a short, sharp, severe pain. When any acid touches an exposed nerve, it tends to cause intense pain. This pain may be relieved, as Sir Dyce Duckworth has shown, by putting into the tooth a little bicarbonate of soda, and occasionally it is advisable to mix the bicarbonate of soda with some sedative such as cocaine or morphine. A little liquid extract of opium with bicarbonate of soda put upon a little pledget of cotton-wool and stuffed in, will often relieve the pain very well.

A local anæsthetic may relieve the pain, even although there be no alkali added to it. One of the best of these local anæsthetics is strong carbolic acid, but you must be very careful in applying this to the cavity of a tooth, that it does not come in contact with the lips or with the tongue. The mistake one is apt to make is to put too much on at a time. The tendency is to make the pledget of cotton-wool too big, so that it will not fit into the cavity of the tooth. Take a small pledget, soak it in carbolic acid, press out the excess, put it carefully into the tooth, and then cover it well with another piece of dry cotton-wool, so as to prevent the tongue from touching the carbolic acid. This will often relieve the pain of toothache immediately.

The teeth sometimes tend to break away for want of a sufficient supply of nutriment. I daresay many of you have heard the reason that has been assigned by some American dentists for the excellence of the dentistry in America. They say dentists are so good in America because the Americans are such inventive geniuses; they have invented mills which turn out the very finest and whitest flour, by which one means that the mills take away all the outside part of the wheat which contains the phosphates and a good deal of the proteid matter and leave only the fine white starch which constitutes the interior of the grain of wheat. In consequence of this the American people get in their bread only pure starch deprived of the earthy salts that ought to be there. Their teeth are starved of phosphates, and so their teeth decay, and because their teeth decay to such an extent the dentist flourishes, and American dentists are in great demand. This seems a roundabout way to get at the excellence of the American dentist, but it is worth while to remember this because it may impress upon you the necessity of phosphates for the nutrition of the teeth. You are sure to hear from some of your lady patients the complaint that they have become pregnant, and during their pregnancy their teeth are dropping away. The reason of this appears to be simply that they do not get in their food enough earthy phosphates to supply the growing fœtus with bone, and to make up for this, an absorption of earthy phosphates takes place from the tissues of the mother. If you give the mother earthy phosphates in her food, you will probably stop, not only the breaking away of the teeth, but the toothache itself of which they complain. In some cases I have succeeded in stopping the toothache by merely giving a little phosphate of lime with their meals, although I gave no local treatment whatever. It is not only in pregnancy that there is a drain upon the phosphates of the mother; it occurs also during lactation, and frequently in lactation it is advisable to give the nursing mother phosphate of lime, not only for her own sake, but for that of the child.

Appendix to Lecture 19.

Movements used by Dr. Schott in the treatment of heart disease as shown to me at Nauheim by one of his assistants, by Dr. Schott's kind direction in August, 1894.

The essential part of these movements is that the movements shall be slow and regular, and that each movement should be fully carried out. The body should be held upright, the joints should be kept straight, and the resistance applied should not be sufficiently great to cause any tremor of the limbs or shortness of breath in the patient. The resistance may either be applied to the patient himself, putting into action the opposing muscles to those which affect the movement, or by an attendant or friend gently opposing the movements.

I. The arms are to be raised slowly outwards from the side until they are on a level with the shoulder. After a pause they should be slowly lowered.

II. The body should be inclined sideways as much as possible towards the right, and then to the left.

III. One leg should be extended as far as possible sideways from the body, the patient steadying himself by holding on to a chair. The leg is then dropped back. The same movements are repeated by the other leg.

IV. The arms are raised in front of the body to a level with the shoulder, and then put down.

V. The hands are rested on the hips, and the body is bent forwards as far as possible, and then raised to the upright position.

VI. One leg is raised with the knee straight, forwards as far as possible, then brought back. This movement is repeated with the other leg.

VII. With the hands on the hips, the body is twisted round as far as possible to the right, and then again to the left.

VIII. With the hands resting on a chair, and the back stiff and straight, each leg is raised as far as possible backwards, first one and then the other.

IX. The arms are extended and the fists supinated. The arms are then extended outwards, next inwards at the height of the body.

X. Each knee is first raised as far as possible to the body, and then the leg extended.

XI. This movement is the same as IX, but with the fists pronated.

XII. Each leg is bent backwards from the knee and then straightened.

XIII. Each arm is bent and straightened from the elbow.

XIV. The arms are brought from the sides forwards and upwards, then downwards and back as far as they will go, the elbows and the hands being straight.

XV. The arms are put at a level with the shoulder, and then bent from the elbow inwards and again extended.

XVI. With the arms in front at the level of the shoulder and the hands stretched, the arms are opened out sideways and then brought together.

XVII. The arms are bent from the elbow outwards and extended.

⁂ There should be a pause of half a minute between each successive movement, such as raising the arms and lowering them, and a pause of one or two minutes between the movements of different kinds, such as I and II.

LECTURE 20.

Action of drugs on the teeth, *continued*—Dyspepsia caused by insufficient mastication—Functions of saliva—Thirst—Sialogogues—Refrigerants—Excretory function of saliva—Antisialogogues—Morphine depresses irritability of salivary centre—Atropine paralyses ends of secretory nerves—Action of drugs on the stomach—Bitters—Irritants—Dr. Beaumont's observations on Alexis St. Martin—Gastric sedatives and gastric stimulants—Bicarbonate of soda—Excretory function of gastric mucous membrane—Hydrochloric acid and pepsin—Importance of gastric movements—Antiseptics in gastric fermentation—Effect of gastric distension upon the circulation.

GENTLEMEN,

At the end of the last lecture I was mentioning to you that the administration of phosphate of lime to patients during pregnancy was sometimes useful in order to prevent the teeth from breaking away, as they might otherwise do; that it was not merely during pregnancy that the draining of phosphates took place from the mother, but during lactation also a quantity of phosphates were expended in supplying the infant with milk. In order to prevent decay of the teeth and toothache in women either during pregnancy or during lactation, it may be advisable to supply them with phosphate of lime. This, I mentioned to you, may be not only beneficial to the mother herself, but to the offspring. I saw a case some years ago which made a considerable impression upon me, because I had told a patient during lactation to take phosphate of lime in order to prevent the teeth from breaking away, and in order to cure the toothache, of which she was complaining. Some time afterwards I heard that her child was suffering from profuse sweating of the head, so that the pillow became drenched whenever the child fell asleep. This is one ot the signs of rickets, a disease which is frequently associated with a deficiency of lime salts in the bones. I at once inquired whether the woman was still taking the phosphate of lime. "No," was the answer. "I supposed that the phosphate of lime was given only for my toothache, and when the toothache got well I ceased to take the lime." I told her to begin the phosphate of lime again. She did so, and the sweats in the child's head completely disappeared; so that the phosphate of lime was beneficial both to the mother and to the offspring.

Now, as I have mentioned, acids are very injurious to the teeth, and acids are frequently generated in the mouth, more especially by the decomposition of food. The usual habit is to brush the teeth on rising in the morning, but probably a great deal of toothache would be saved if, in addition to this, the teeth were brushed the last thing at night before going to bed. The reason is that very frequently small particles of food lodge in the interstices between the teeth, and these undergo decomposition during the night and give rise to the formation of acid; and, as the secretion of alkaline saliva ceases almost entirely during the night, the acid has time to work upon the teeth, and thus to eat into them and corrode them. Now the use of the teeth is a most important part of the digestive process, and you will frequently be called upon to treat cases of dyspepsia which depend upon insufficient action of the teeth. Insufficient action frequently is due to want of care and to hurry. There are many people who are engaged in busy lives who think they have not time to eat; they forget an old saying: "Time spent in meat and mass is never lost." They hurry through their meals, and the consequence is that by-and-by the stomach begins to rebel. The food is sent down in an unbroken state, and so it is not digested in the stomach. They treat their stomachs as a gizzard, but it is not a gizzard, and resents, as it is termed, "being put upon." It will act for a length of time, and do a great deal more than its fair share of work, but the time does ultimately come when it gives out, and patients begin to complain of dyspepsia. I think it was really a stroke of genius on the part of the late Sir Andrew Clark when he made his patients count their bites. The rule is, the mouth contains 32 teeth, so that to every mouthful of animal food you must give 32 bites in order that every tooth shall have a chance. If the food is at all tough you must double the number, and give 64 counted bites, and sometimes it may be requisite to give even more. Of course for soft food such as bread and potatoes, and so on, this number of bites is not requisite; but if you try yourself and count the number of bites required completely to comminute a bit of beefsteak, you will be rather astonished, for you will find that 32 bites are barely sufficient to comminute it sufficiently, and really you may find you want 64. One, of course, is reckoning that the teeth are all there, but very often they are not all there, and one of the most deceptive conditions that you meet with in the mouth is somewhat as I show in the diagram. In the upper jaw, for instance, you may have a very good grinder, perhaps two; and in the lower jaw you will perhaps find two good grinders; but then it often happens that the position of the grinders is such that there is almost no opposing surface between them, so that the total grinding surface in such a case is exceedingly small (Fig. 120). Of

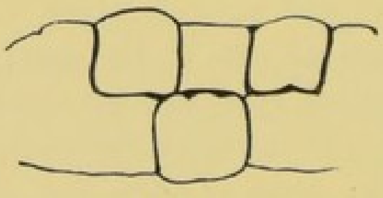

FIG. 120.

course there is a little more surface than that really used for grinding. The surfaces indicated in the diagram are the only ones that oppose during rest, but it must be remembered that the jaws have got a to-and-fro motion, and by this means the grinding surface can be to some extent increased. Still, when the teeth are disposed in the form I have drawn, there is very little power of grinding. The food makes its way between the teeth into the interstices, and it is hardly comminuted at all, and when you look into a mouth of that sort you are deceived by the apparent number of teeth in the jaws. As you see, the only function of the teeth there is that they prevent the gums from coming in contact with one another, and the person would be really better, as far as mastication goes, without any teeth at all, because then the gums could rub upon one another, and to a certain extent comminute the food. In cases of this sort patients very often cut up their food, not with their grinders but with their incisors, and then it is as a rule very imperfectly done indeed.

I saw a little while ago an incident that struck me a good deal in regard to comminution of food. I had an old pony, and it was beginning to show signs of decay. I thought this was the natural decay of old age, and that there was no further hope for the pony, but that it would get stiffer and stiffer, weaker and weaker, and finally die. But the man who was in charge of it was shrewd and observant, and he said: "The oats are passing undigested through the pony. Would it not be better to have the oats ground and made into a mash?" The oats were ground and made into a mash, and thus supplied to the pony, which became at once ten years younger, and continued to go on perfectly well without any further indication of old age. The pony was suffering from old age, but old age does not affect all organs at the same time; and very many people get old in their teeth sooner than elsewhere, and that was the case with the pony. If you can supply the missing function and bring it up to the mark, you will increase the length of time during which the whole organism will go on; therefore attention to the teeth is often a way of prolonging life, and it has been said, and with a good deal of truth probably, that the great increase in longevity of late years is really due to the dentists, who supply teeth to those who otherwise would not have them.

There can be, I think, no doubt whatever that longevity has increased enormously, especially within late years. It is just about twenty-five years ago that a book was written by a very distinguished zoologist in this country to prove that no man ever reached the age of 100 years. I do not believe that anybody now would think of writing such a book, because the cases in which people have reached the age of 100 are so numerous and well authenticated that no one could deny the fact that people do reach this age. I think it is almost certain that this increase is due to the simple fact that people can continue now to masticate their food for a very much longer period than before.

I do not know that I have any more to say just now about teeth, and we may therefore pass on to the saliva.

Functions of Saliva.—The saliva has two functions: the one is to keep the mouth moist; the other is to digest the farinaceous parts of our diet. By keeping the mouth moist, the saliva enables the tongue to move more freely, and when the saliva is dried up the movements of the tongue are much impeded, so that in cases of extreme thirst, as the phrase goes, "the tongue cleaves to the roof of the mouth," because, not being moistened by saliva, it becomes dry, hard, and inflexible, instead of being soft and mobile, as it usually is. Thirst, as a general condition, depends upon want of water in the system, but thirst is also a local condition, and the general want of water in the system appears to make itself felt first of all in the mouth and throat. You can relieve thirst by giving water, either by the mouth or by the rectum, so that it shall be absorbed; but you can often relieve thirst, as many of you know, without drinking any water, by simply washing out the mouth and gargling the throat with water, without swallowing any of it. Moreover, thirst can often be relieved without any water at all, and one of the common practices amongst people who are taking walks, and who are not likely to come across water, is to put under the tongue a bullet or a pebble. Now the action of this is two-fold. First of all, by putting the pebble under the tongue you are almost obliged to keep the mouth shut, and this prevents drying of the tongue by the passage of air through the mouth and fauces. In addition to this, however, the chewing of the pebble is a mechanical stimulus to the sensory nerves of the mouth and causes a reflex secretion of saliva. There are some other things that act still more powerfully; a little bit of pellitory, for instance, causes a more abundant secretion of saliva than the pebble. If you put into the mouth a little acid or a little ether, you will find the secretion of saliva is greatly increased, and one of the common ways of getting quantities of saliva for the purpose of analysis is simply to breathe into the mouth ether vapour and allow the saliva which then streams from the glands to flow into a glass.

Sialogogues.—Ether vapour, however, is not often used as a sialogogue. One more frequently employs dilute acids. Dilute acids, therefore, lessen thirst, and, on account of the thirst being accompanied by a feeling of heat, those medicines that stimulate the secretion of saliva tend to lessen the feeling of heat, of thirst, and of discomfort, and so they are called "*Refrigerants.*" Not that they diminish the temperature of the body, but they make the patient feel cooler. Just as keeping the mouth shut tends to lessen thirst, so if you can cover the back of the throat with any substance that tends to keep the mucous membrane moist, you lessen thirst also. One of the commonest additions to water for this purpose is some mucilaginous substance, and one of the best of these probably is oatmeal. In foundries where men are subjected to intense heat, and therefore are constantly perspiring tremendously, the workmen become intensely thirsty in consequence of the loss of water through the skin, and the custom is to supply them with water in which oatmeal has been stirred. The heavier particles of the oatmeal fall to the bottom, and a milky-looking fluid results, which tends to quench thirst exceedingly well. The same thing holds good in cases of fever, for we find that sometimes this simple oatmeal and water tends to quench the thirst of feverish patients. Besides this, we are in the habit of giving our feverish patients liquids containing acid, either citric or tartaric, and this is frequently flavoured with a little lemon or orange, more especially lemon, because lemon seems to have an action also as a sialogogue. The volatile oil of lemon combined with citric acid forms a more efficient refrigerant and a more efficient sialogogue than either the one or the other separately.

Excretory Function of Saliva.—The saliva contains various substances, especially chloride of sodium and salts of lime, and when certain bodies are taken into the digestive canal they are absorbed from it and excreted through the saliva. More especially is this the case with iodide of potassium, which constantly passes out in the saliva, and passes out very quickly. People frequently complain of a peculiarly disagreeable taste in the mouth after they have been taking iodide of potassium, and it seems to me that if you give some bitter substance, such as quinine, at the same time as iodide of potassium the quinine which would not be otherwise excreted does pass out in the saliva along with the iodide of potassium. I have very frequently found that patients at the Hospital complain of the persistent bitter taste which is caused by the Hospital draught containing quinine and potassium iodide, and there has been no explanation that I could think of, except that the iodide of potassium had increased the excretion of quinine through the salivary glands. Some curious experiments have been made upon this point by Claude Bernard. He found that if one injects into the blood lactate of iron, no iron passes out in the saliva; if one injects iodide of potassium, the iodide of potassium passes out in the saliva. If you inject into the blood lactate of iron first and iodide of potassium afterwards, no iron appears in the saliva, because you have not got the two mixed; if you mix the lactate of iron and the iodide of potassium in a vessel before injecting the mixture, or give them together by the stomach, so that iodide of iron is formed, iodide of iron appears in the saliva. In all probability the salivary glands have the power of excreting other substances, formed in the intestines, so that we frequently are able to get rid of a persistent bitter taste in the mouth by the administration of a purgative, and more especially of a mercurial purgative.

Sometimes, instead of the secretion of saliva being too scanty, we find that it is too abundant, especially in the case of some irritation in the mouth. The irritation of a decayed tooth, for example, may lead to reflex secretion of saliva, and we lessen this by the use of such substances as will have a beneficial action upon the mucous membrane of the mouth, viz., washes of borax and chlorate of potash, and by astringents, such as myrrh, or tannic acid, or gallic acid. We can also, however, lessen the secretion of saliva, not only by diminishing the intensity of the afferent stimulus in the mouth, but by rendering the nerve centre through which the reflex action occurs less sensitive. This is done by the use of morphine, which tends to lessen secretion in the mouth. It does this when the secretion is too abundant, but it does it also when the secretion is normal; and so you will frequently find that after you have given morphine for the purpose of relieving some other condition the patient complains of dryness in the mouth, because you have lessened the excitability of the reflex centre for the secretion of saliva, in the same way as you have diminished the irritability of other nerve centres. But sometimes you may find that morphine is insufficient to stop the secretion of saliva, and in this case the most powerful of all drugs is atropine. Atropine acts upon the ends of the secreting nerves in the cells themselves. It paralyses them, so that the secreting nerves have no more power over the salivary glands, and you may irritate those nerves by a strong induced current without any result whatever.

Action of Drugs on the Stomach.—We may now pass from the mouth to the stomach. The condition which leads one to take food is usually known as appetite. The cause of appetite is not very well known. In all probability the final cause is some slight irritation of the gastric nerves, which is frequently, if not always, associated with a certain increase in the circulation of blood through the gastric mucous membrane. When appetite is wanting we can frequently stimulate it by various drugs, and these chiefly belong to the class of bitters. There are three classes of bitters:—

1. Pure bitters.
2. Astringent bitters.
3. Aromatic bitters.

An example of pure bitters is calumba, of astringent bitters decoction of cinchona, and of aromatic bitters cascarilla or orange. All these taken before a meal frequently bring on a feeling of appetite, and the same is the case if, instead of taking a bitter, a stimulant such as alcohol has been taken. Very frequently a combination of the two is used, and men about town who eat and drink more than is good for them, and, perhaps, take too little exercise, are frequently in the habit of going to their club and taking a sherry and bitters about half an hour before dinner, so as to stimulate their appetite. There are various other substances which excite appetite, *e.g.*, irritants, which in the further stage of their action would cause decided pain. For example, a small dose of arsenic will increase the appetite very greatly, but in large doses it will cause excessive pain in the stomach and in the intestines. There are various other drugs besides arsenic which have this action, and it is said that even antimony in small doses will cause an increase of appetite.

There can be no doubt whatever that increased appetite, in fact a voracious appetite, is frequently a sign of commencing so-called biliousness, the increased appetite being succeeded by loss of appetite, and finally by sickness. Our knowledge of the pathology of this condition is chiefly due to the observations of Dr. Beaumont upon Alexis St. Martin, whose death you may have seen announced about four or five years ago. Alexis St. Martin was a Canadian *voyageur*. One day he was out hunting, and another fellow, who was not a very good shot, let fly a charge of duck-shot, which struck him below the left nipple, and made a large hole in his stomach. The wound healed up, but a large hole was left in the side, to which the stomach became adherent. Through this hole Dr. Beaumont could readily see into the stomach. It was usually closed by a flap of mucous membrane, but by simply pushing the flap back Dr. Beaumont could see all that was going on in the stomach. By means of gastric fistulæ in dogs, Bernard confirmed and extended Beaumont's observations, and for brevity's sake I shall class them together. On looking into the stomach they found that when nothing had been eaten and the organ was at rest, the mucous membrane was pale and was not secreting, but if the experimenter took a glass rod and stirred up the interior, or tickled it with a feather or put a little food into the stomach, or caused any food to be swallowed, the mucous membrane at once became rosy, and secretion of gastric juice commenced. He could see little drops oozing from the gastric glands like the drops of perspiration on a man's forehead. These gradually coalesced, and running together in a little stream, accumulated in the larger curvature of the stomach. At the same time when he stirred the mucous membrane up in this way a feeling of appetite was induced, but if he stirred it up a little more forcibly the mucous membrane became changed in colour—the rosy red disappeared; it became white—the secretion of gastric juice stopped, the secretion of mucus began, and the appetite disappeared. If he stirred a little more forcibly still the patient began to feel sickness and nausea. You see then that while a little irritation may cause increased appetite, and tend to increase the digestion of the food, a little stronger stimulus will tend to lessen the power and interfere with digestion.

Gastric Sedatives and Gastric Stimulants.—You will notice in some cases which come before you that the patient complains of a tremendous appetite when he sits down to meals, but after a few mouthfuls the appetite is satisfied, and he is not able to eat any more. The condition here no doubt is that the mucous membrane is already in a state of intense stimulation, and the additional stimulus of the food makes the stimulation pass from the first stage of increased circulation to the second stage of diminished appetite, with arrested secretion and pale mucous membrane, preliminary to the third stage, in which we get nausea and vomiting. In such cases it is no use to give bitters. What you want to do is to soothe the stomach down. You do this best by the administration of such substances as bismuth, hydrocyanic acid, and, if necessary, opium in small quantities. You thus lessen this craving appetite, and when the patient comes to sit down at meals he is able to take more food. In other cases, again, you find that the patient has no appetite at all when he sits down, but that the appetite comes with eating, and he eats a good deal. Here the condition is in all probability quite a different one. In such a case you have got an anæmic lax condition of the stomach, so that there is no appetite before the patient sits down, but when the stimulus of food is applied to the stomach, then appetite comes; circulation becomes increased, the mucous membrane begins to secrete, and the patient gets on perfectly well. In these lax conditions you may frequently find a good deal of benefit result from the administration of bitters, and even of iron. One of the preparations of iron that one finds exceedingly useful, especially in patients who are badly fed, is one in the Hospital Pharmacopœia, haustus quassiæ cum ferro, in which we have simply the solution of perchloride of iron with infusion of quassia. I should perhaps mention that we generally consider only two infusions can be prescribed along with iron, viz., infusion of calumba and infusion of quassia. The reason why these may be given so well with iron is that they contain no tannin, and so they do not cause any black, inky, disagreeable colour in the mixture. But although these two infusions are usually said to be compatible with iron, the other infusions are not incompatible. You may give infusion of gentian, or infusion of cinchona, with iron, and they will act perfectly well together for all practical purposes, but they do form an inky-looking mixture, which the patient may not like to take. As far as their action upon the stomach is concerned, they are perfectly compatible and complete.

There is one drug that is perhaps more used in the treatment of gastric disorders than any other, viz., bicarbonate of soda ; and the way in which it is to be employed varies according to the results that you wish to obtain. If you put into the stomach 10 grains of bicarbonate of soda what happens ? Ten grains is a small quantity, and if you put this into a full stomach where there is a large amount of gastric juice it will simply be neutralised by the gastric juice and will neutralise a corresponding quantity of gastric juice. You will not get very much effect from such a small quantity ; but if you put 10 grains dissolved in water, along with a bitter infusion, into an empty stomach, the result will be quite different. Then it gets a clear field and passes over the whole mucous membrane of the stomach, and it excites secretion of gastric juice ; so that if you give these small quantities of bicarbonate of soda, not less than a quarter of an hour, and I think, better still 20 minutes or half an hour, before meals, secretion of gastric juice is brought about. The food when it reaches the stomach meets gastric juice ready to digest it, and digestion goes on normally. The formation of butyric acid and its allies and the decomposition of the food are prevented, and thus you frequently find that this very simple remedy stops severe dyspepsia. We have it in our Hospital Pharmacopœia, haustus calumbæ alkalinus, where we have only 10 grains of bicarbonate of soda with some tincture of calumba and tincture of orange to flavour. This draught used to be made with infusion of calumba, but the infusion, although made with cold water, so as to avoid to a great extent the starch that is present in the root, still contains a good deal of starch ; this in hot weather undergoes decomposition, and so it was found that Hospital patients who had got their week's supply of haustus calumbæ alkalinus frequently came back in two or three days saying the medicine had gone bad. Now we use the tincture instead of the infusion of calumba. Still the infusion is largely used in private practice, because the patients do not require to have the medicine supplied to them in such large quantities. It is sufficient if they have enough for two or three days, as they can easily get it renewed again. Hospital patients have sometimes to come a considerable distance for medicine, and the time spent in going backwards and forwards makes a great inroad upon their small earnings.

I have mentioned to you that the appetite is closely connected with the circulation of blood in the stomach. You can readily understand that if there is an obstruction to the circulation of venous blood from the stomach, you are likely to have the appetite interfered with. It is a great thing to remember that all the blood in the stomach has to pass through the liver before it can get back into the general circulation (Fig. 121) The blood passes up from the stomach through the portal vein and on through the liver into the general circulation; then it has to pass through the portal circulation, and if the liver presents any obstruction to the flow of blood through it, you can readily understand that you are likely to get a certain amount of venous congestion in the stomach. During digestion the liver-cells are very swollen, and I do not see that they can do otherwise than press upon the capillaries, and thus lessen the passage of blood from the stomach through the liver (Fig. 123). Whether it is by diminishing the obstruction to the flow of blood through the liver or not I cannot definitely tell you, because here we are trenching upon the boundary-line between fact and fancy; but, as a matter of fact, you will find that frequently patients who complain of great loss of appetite and inability to take food will regain their appetite if you give them a calomel purgative at night followed by a dose of salts and senna in the morning.

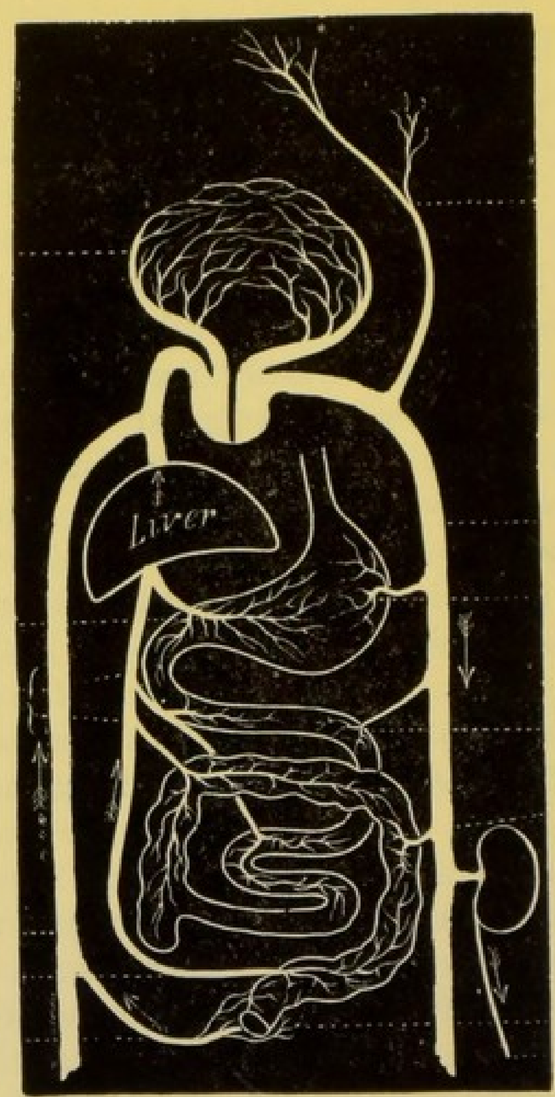

FIG. 121.—Diagram of the veins forming part of the portal circulation. The pancreatic and splenic veins, although most important, have been omitted for the sake of clearness.

Excretory Function of Gastric Mucous Membrane.—It is quite possible, however, that this acts in another way. I have spoken of the excretion of various drugs through the salivary glands, but the same thing takes place with the mucous membrane of the stomach. If you inject into the vein of a limb a quantity of tartar emetic it passes into the general circulation, is carried by the blood to the stomach, as it is to other organs, and there it is excreted by the mucous membrane; so that if you kill an animal and scrape the mucous membrane of the stomach a couple of hours after the tartar emetic has been injected, and then analyse the mucus, you will find tartar emetic is present.

What happens with this also happens with other drugs. Snake venom is excreted in exactly the same way, and various poisonous albuminoids are also excreted in cases of cholera. Loss of appetite is frequently due to the presence in the stomach of various products of the nature of ptomaines or albumoses, and by the administration of a mercurial saline purgative you sweep those away and thus allow the stomach to regain its normal

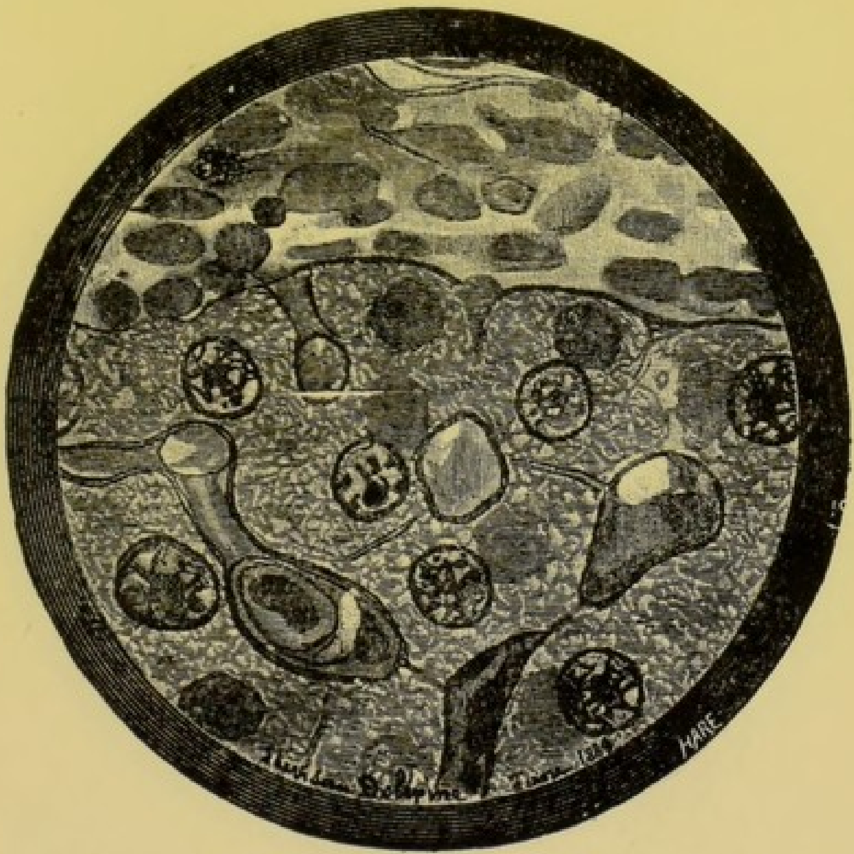

FIG. 122.—Fasting liver. Rabbit six weeks old; last food, $18\frac{1}{2}$ hours before death. (After Sheridan Delépine.)

condition. When bile is present in the stomach there is generally a loss of appetite and a feeling of sickness and nausea, and not unfrequently you will note that the patient is sick after taking food. He often cannot bring anything up, but he may, after a great deal of retching and straining, bring up a teaspoonful of bile mixed with mucus. In many cases instead of giving a drug which will lessen the excitability of the stomach, such as, for example, hydrocyanic acid, you will attain your object of lessening irritation by giving the patient a quantity of hot water and telling him just to be sick, and if the water which comes up is strongly tinged with bile let him take more water and again be sick, and go on continuously washing the stomach out in this way until the water becomes free from bile. After this if you give him some hot milk he will probably keep that down, and you will have no more trouble.

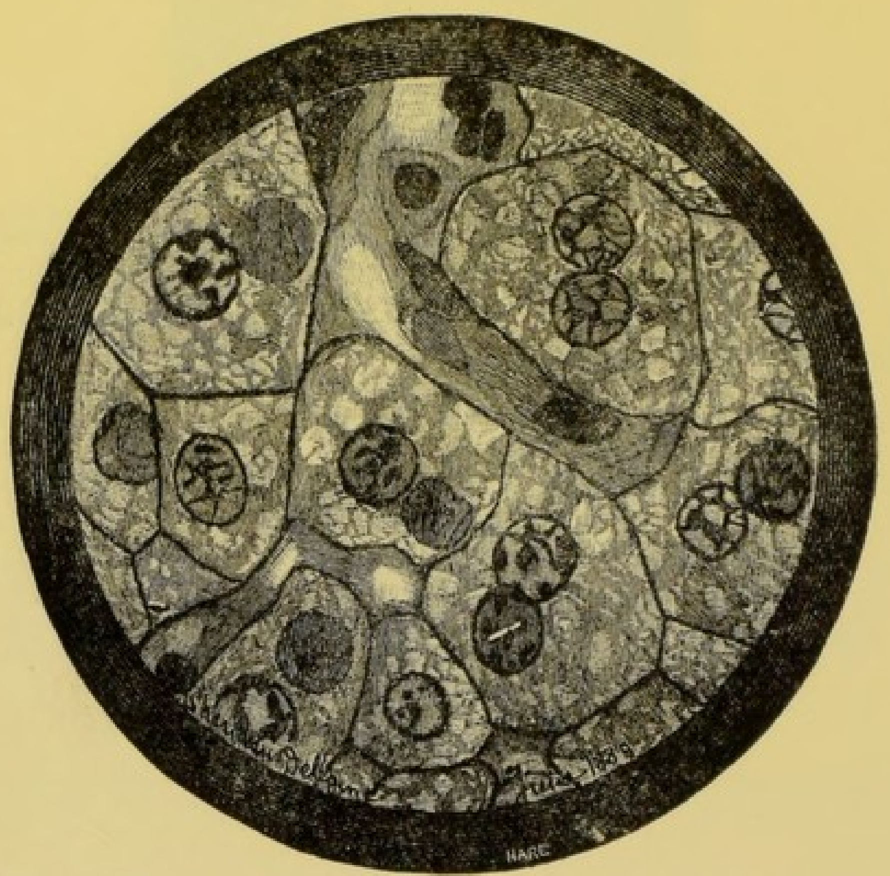

FIG. 123.—Active liver. Rabbit six weeks old, killed six hours after meal. (After Sheridan Delépine.)

The stomach frequently seems to be unable to secrete the substances wanted for the digesting of food. These are, as you know, hydrochloric acid and pepsin. I mixed before this lecture some pepsin, hydrochloric acid, and fibrin, and already the fibrin has become considerably diminished in quantity, and what remains is soft and quite loose in texture, very different indeed from the ordinary fibrin, which is quite hard, quite white, and opaque. Here it is translucent, and a great deal has already been converted into a soluble substance. Of course at the temperature of the body this process goes on still more quickly. In cases where the constituents of gastric juice are deficient, we frequently are able to supply them by giving either pepsin or hydrochloric acid, or both together, towards the end of a meal, or shortly after it.

Rennet.—There is another ingredient in the gastric juice to

FIG. 124.—Action of atropine on an active liver. Rabbit six weeks old; last food, $5\frac{1}{2}$ hours before death. Injection of $\frac{1}{150}$th grain atropine 3·2 hours before death. (After Sheridan Delépine.)

which but little attention is paid, and that is rennet, but I have seen certain preparations of so-called pepsin essences, wines, and so on, which contained very little pepsin indeed, almost none, and I was astonished to find that they really acted very well in certain cases of dyspepsia. On investigating the chemical nature of these substances more carefully, I found that these wines contained a good deal of rennet, and so I am inclined to think that the rennet exercises a more powerful influence on digestion than is usually supposed; but the action of rennet upon digestion has not been carefully worked out as yet.

The movements of the stomach have a great deal to do with digestion, because you can readily understand that if I leave the fibrin quite untouched it will take a longer time to digest than if I were to stir it up constantly and break it up

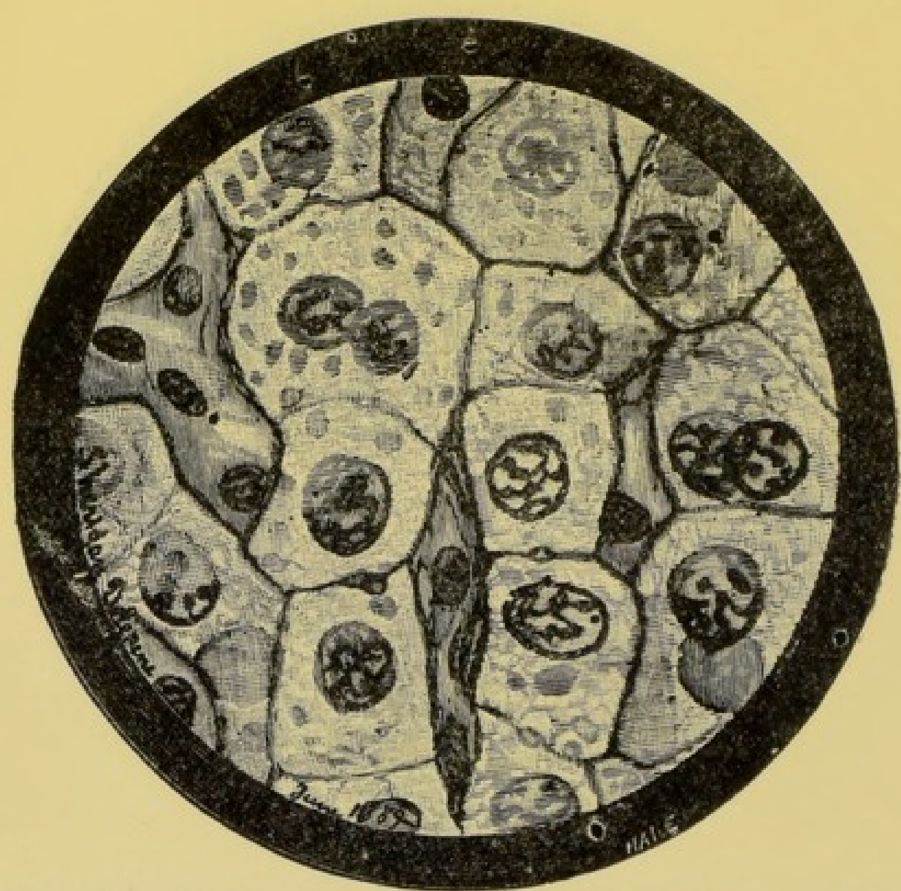

FIG. 125.—Action of pilocarpine on a fasting liver. Rabbit six weeks old; last food, 17½ hours before death. Injection of ½ grain pilocarpine 1½ hours before death. (After Sheridan Delépine.)

mechanically thus bringing each part of the fibrin continuously into contact with new portions of acid and of pepsin. The movements of the stomach have a powerful influence both in breaking up the food mechanically, and in aiding the solution of the food by the gastric juices. Sometimes you find that the stomach is very deficient in movement. This may be due simply to want of nervous tone, and in such cases we are in the habit of giving nux vomica or strychnine. Great assistance also is given by mere mechanical rubbing, rubbing the stomach from the left towards the right in the direction of the pylorus. When these fail, we may have recourse to galvanisation of the stomach, passing an interrupted current through the stomach, a large plate being put upon the back, and another plate upon the epigastrium, and a current passed through. Now, the stomach is like a class at school. You may find in a class at school

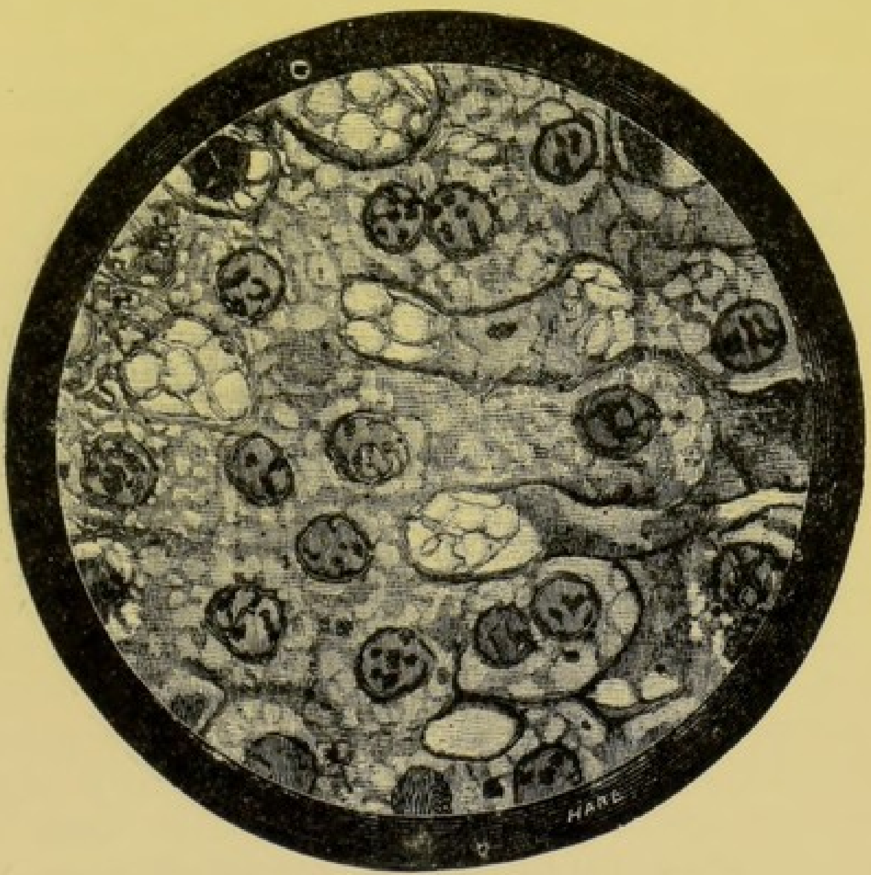

FIG. 126.—Action of toluene on active liver. Rabbit six weeks old; last food, 6½ hours before death. Toluene (1 minim) five hours before death. (After Sheridan Delépine.)

that a single lazy boy may keep the whole of the rest of the class back because he cannot pass the standard, and the others will go on learning a lesson time and again, until they all get perfect except the lazy boy. The same thing happens in the stomach with a bit of undigested food. You will find that cheese will digest anything but itself. The lump of cheese is the lazy boy. Supposing you put into the stomach a big lump of cheese. Cheese, as you know, is rather hard, and unless the teeth have done their fair share of work upon it, it will be apt to pass down as a pretty big, hard lump, and will be very slowly acted upon by the gastric juice. It is sent round and round the stomach, and goes up to the pylorus, but it will not get through; the pylorus will not have it. Whenever you try to pass anything through a sphincter it has got a tendency to contract, and a good example of this is to be seen, or rather

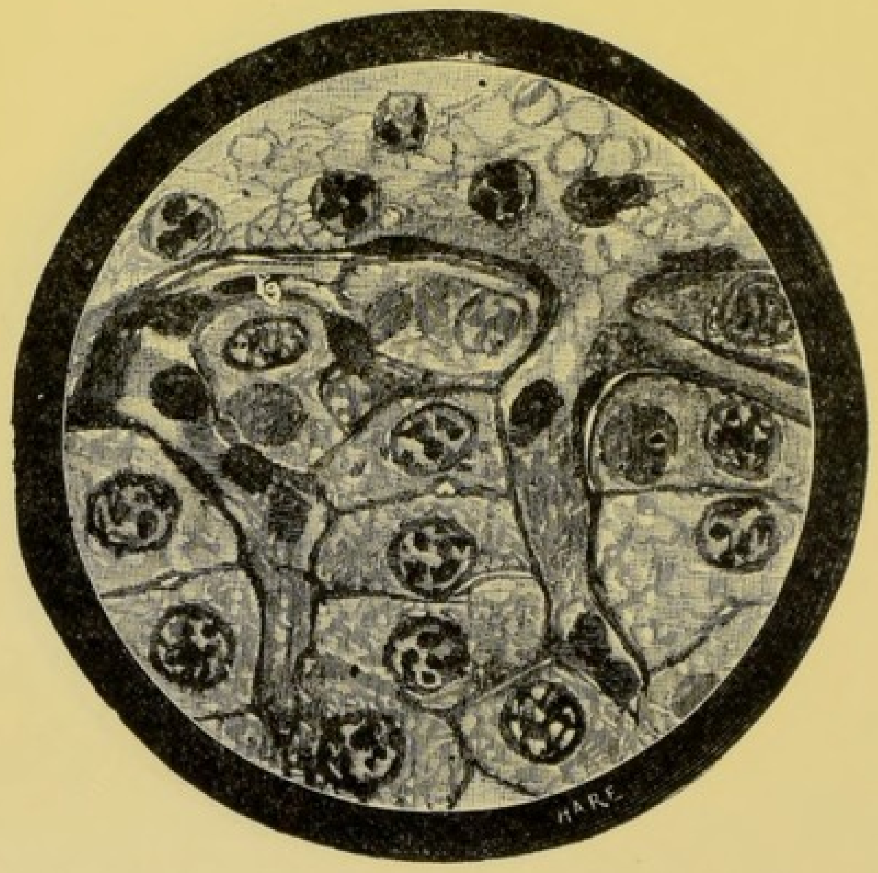

FIG. 127.—Action of toluene on fasting liver. Rabbit six weeks old; last food, 20 hours before death. Toluene (1 minim) $4\frac{3}{4}$ hours before death. (After Sheridan Delépine.)

felt, upon examining the rectum. If you pass the finger into the passage, you will find the muscle tends to contract. The same occurs with the pylorus: it contracts, and will not let the cheese through. The whole of the rest of the food is digested, but the bit of cheese remains, and so the common proverb is quite true that "cheese digests everything but itself." After the whole of the food has become digested it undergoes further chemical change. If it remains in the stomach the chances are that it will then begin to, in part at least, undergo fermentation. Gases and acids are formed, and by-and-by the whole of the fluid in the stomach becomes exceedingly acid and acrid, and the irritation is so great that the whole of the juice, instead of passing through the pylorus, may come up through the œsophagus, whereas, if the patient had only taken the trouble to chew the cheese up thoroughly, it would have got through the pylorus, and would not have kept the other food back after it had been digested, and thus the whole of the meal would have been digested in a normal manner.

In cases where the pylorus is contracted you generally find that the stomach tends to get much dilated, and sometimes you may get relief by allowing the patients to lie on the right side, with their hips a little raised, and gently pressing the stomach, so as to get fluid mechanically out of it. It very often happens that little portions remain in the stomach between meals, and these act as sources of decomposition. I daresay you know that if a baker once gets his tubs sour it is very hard to produce sweet bread. If he gets into his tubs some of the bacteria that make it sour, they will give him a deal of trouble. The only thing to do is to scald the tubs so as to destroy the bacteria which give rise to the acid fermentation. In the same way with the stomach, if you have got a dilated stomach which does not empty itself satisfactorily between the meals, you have remaining behind a lot of germs which reinoculate every meal as it is taken, and give rise to the formation of acid or of gas or of both. In order to prevent this you must either remove the bacteria by washing out the stomach, or kill them by the use of antiseptics. You will sometimes get astonishing results by the administration of antiseptics in such cases. I have seen 1 fluid drachm of the sulphurous acid of the Pharmacopœia thoroughly diluted, stop, and stop for a length of time, the vomiting which had been going on for two or three weeks together in a case of this sort. Carbolic acid is another antiseptic that one uses very freely in order to lessen flatulence arising from fermentation. It may be given in doses from half a grain to 2 grains made up in the form of a pill, and generally taken with the meal. Creosote is another; 2 or 3 minims are generally given in the form of pearls or little capsules, and these have a similar action. Salicylate of bismuth and sulpho-carbolate of soda have also a similar action to that of carbolic acid and creosote. The sulphocarbolate of soda is a very good medicine indeed, and it is usually given in about 10-grain doses. Salicylic acid has a similar action, and it used to be a great favourite with Professor Kussmaul, in 5 or 10-grain doses during or just after a meal. By the use of these drugs fermentation and the accompanying discomforts may frequently be prevented. Another substance which has in many cases a powerful action in lessening discomfort and flatulence is charcoal. How the charcoal acts one does not know, but there is no doubt that it does act very powerfully. It is generally given in the form of a biscuit, or in the form of toast or charcoal powder, and a teaspoonful of charcoal powder along with milk will frequently tend to lessen the formation of gas and of acid.

I have not brought with me to-day the apparatus for showing you the lavage of the stomach, but I will show it to you at next lecture. In cases where the pylorus has completely contracted—and sometimes you may find it so contracted from old ulcerations that even a probe will hardly pass through it—it is quite evident that no washing out of the stomach nor administration of drugs will do much for the patient, and till within a few years we were simply powerless in regard to their treatment. The best method of treatment is to call in the aid of a surgeon, who will connect the stomach and the duodenum and make an artificial pylorus, and in a good many cases this method of treatment proves perfectly successful.

If the stomach cannot empty itself, it is very apt indeed to interfere with the circulation; and I mentioned to you before that very frequently gas in the stomach tends to interfere so with the action of the heart that you may get fainting, and even death. Some time ago I saw an account in the papers of a man who suddenly died after a meal, and on post-mortem examination it could not be discovered what he died of. All that the doctor found was that the stomach contained a very large quantity of potatoes and milk. I have no doubt whatever that the cause of death simply was the enormous distension of the stomach, which either reflexly or directly caused stoppage of the heart. There used to be in the Middle Ages a way of poisoning people which was used, not only as a method of killing them, but, to a certain extent, of torturing them. It was that of causing them to drink a large quantity of bull's blood. Now bull's blood in itself is not a poison, but if taken in sufficiently large quantity direct from the veins of the animal you can understand that when poured into the stomach the coagulation which usually occurs in a pail outside the body would take place in the stomach of the victim. There would then be an enormously large, hard clot formed, upon which the movements of the stomach would have no power whatever, and so the movements of the heart would consequently be interfered with. This is what actually occurred. When large quantities of water are taken they tend to distend the stomach. So we sometimes find that in consequence of visits to German watering-places, where large quantities have been swallowed at once, the patient suffers from a tendency to dilatation of the stomach. This has also been observed when people have been during the summer very thirsty, and instead of taking their liquids in small quantities frequently repeated they have taken large draughts at a time. This dilatation is treated in the way I have mentioned, viz., with stimulants such as strychnine and with massage and electricity.

Another condition that is very troublesome is when a large amount of acid is formed in the stomach. The fluid comes up and burns the mouth, and corrodes the teeth. Here we find that the bicarbonate of soda is a great help in treatment, but it is employed in a way different from the one I described above. Instead of giving 10 grains before meals, which would be of very little use, you give it after meals, but in much larger quantity: in doses of half a drachm to a drachm and more. It is very often said that this method of treatment weakens the coats of the stomach, but I do not think it practically does anything of the sort. I have seen a case in which this treatment has been continued for 30 years by the patient herself—not by the direction of the doctor—but without any apparent harm being done. If the patient had submitted to the doctor's direction, in all probability this continuous administration of the bicarbonate of soda would not have been required, because by proper treatment the acidity would have been prevented, and so the patient would not have required to take antacids to this extent in order to lessen the acidity.

LECTURE 21.

Migraine—Washing out the stomach—Emetics—Local and remote emetics—Physiology of vomiting—Treatment of vomiting--Heat and cold—Gastric sedatives—Cocaine—Opium—Sea-sickness—Treatment—Pressure—Position—Drugs—Bromide of potassium—To be given well diluted—Counter-irritation—Carminatives—Action of drugs on the intestines—Increased peristalsis—Increased secretion—Bitartrate of potash—Magnesium sulphate—Mistura Sennæ Co.

GENTLEMEN,

At the end of the last lecture I was mentioning that very frequently a process of fermentation takes place in the stomach by which various organic acids are formed. Unlike hydrochloric acid, these organic acids have very little power to aid pepsin in digesting proteids. On the contrary, they seem rather to interfere with digestion. Sometimes you may find that the contents of the stomach when evacuated are exceedingly acid and exceedingly irritating to the stomach, to the fauces, and to the mouth. Yet at the same time this very sour fluid may contain very little hydrochloric acid, and be very inefficient as a digestive agent. This excess of organic acids may be neutralised, and the comfort of the patient greatly increased, by the free use ot an alkali, such as bicarbonate of soda; but, as I mentioned to you before, prevention is a great deal better than cure, and although you may relieve the patient by giving bicarbonate of soda after a meal, yet this does not tend to prevent the recurrence of the acidity; in fact, it may possibly rather tend to increase it. In order to prevent acidity, one of the best things you can do is to get the food quickly digested in the stomach and quickly removed from the stomach, but when there is any interference to the passage of food from the stomach, either on account of the nature of the food itself, or on account of the narrowing of the pyloric orifice, then the contents of the stomach will tend to accumulate in it. A similar accumulation may take place in consequence of disturbance of the nervous apparatus of the stomach. Most of you know that if you get a sick headache coming on before a meal, it is very likely that several hours afterwards you will bring up all that you have eaten undigested; if the headache comes on an hour or an hour and a half after you have eaten, you will bring up all the food, but this time it will be digested. The reason of this is that the changes in the nervous system associated with migraine appear to cause stoppage of the secretion of gastric juice, so that the food taken after the onset of the headache is not digested. But if the headache has not begun until the digestive processes have taken place, the food, although partially digested, is still brought up. The reason for this appears to be partly that the process of absorption has been arrested so that there is little or no absorption from the stomach and partly because the movements of the stomach itself appear to have ceased during the migraine, so that the food is not ejected from the stomach into the intestine. The fact is that in migraine we seem to find in the stomach very much what occurs in the blood-vessels. If any of you suffer from that ailment, just try the experiment of putting your finger upon the carotid on the two sides, and you will probably observe that the carotid on the painful side is widely dilated and throbs furiously, but if you follow the artery higher up, when you get to the temple you may feel the artery still dilated and throbbing, or you may find it contracted like a bit of whipcord. In all cases, if you follow the artery far enough, you will find the contraction, and when you come just across the brow you will probably find the artery like a bit of piano-wire. Thus we see in the arteries of the head and neck during migraine there are proximal dilatation and distal contraction. Exactly the same thing seems to occur in the stomach. In migraine, instead of the stomach being of moderate size, it is largely distended, and it would appear that the pyloric end is firmly contracted; so that during this condition there is proximal dilatation and distal contraction, resulting in temporary dilatation of the stomach.

When there is organic stricture of the pylorus, dilatation is permanent instead of being temporary, and then we find a tendency to accumulation of the food and to great decomposition. The patient often brings up an enormous quantity of food at once. Perhaps as much as he has taken during a couple of days seems to accumulate in the stomach, and is brought up with one great gush. This food is often frothy, exceedingly acid, and very disagreeable in smell.

Washing out the Stomach.—Sometimes these symptoms are greatly relieved by emptying the stomach either by taking a quantity of warm water and tickling the fauces or by washing out by the aid of the stomach-pump. There are a great many people who object to the stomach-pump, and you will find that a large number of them will submit to the process of washing out the stomach by drinking repeated draughts of hot water and tickling the fauces with a feather when they will not have the stomach-pump on any account whatever. Yet, if you can induce them to try the stomach-pump, it is perhaps an easier and more efficient way of giving them relief. I do not wonder at people being afraid of the old-fashioned stomach-pump; in fact, I have been afraid of it ever since I saw a post-mortem where a pint of beef-tea was found in the posterior mediastinum. I did not put it there myself, but a fellow resident physician did. Nobody expected it, but on post-mortem examination it was found that one of the very hard tubes which were in use in those days had passed right through the œsophagus and gone into the posterior mediastinum, and when the syringe was used a quantity of beef-tea was pumped, not into the stomach, as was intended, but into the posterior mediastinum. The tubes then used were very hard, so that a great deal of mischief could be done with them, and although they became a good deal softer when placed for a short time before use in hot water, still they were sufficiently hard to be more or less risky. A patient could not use this apparatus himself. There is attached to the syringe which I show you an arrangement by which one can shift the stopcock and draw the liquid in from one tube and then send it out through the other. This syringe has now, however, been quite replaced in ordinary washing out of the stomach by a soft rubber tube, which I show you. In one case life was saved by the ingenuity of a medical man, Professor A. Ewald, who, not having anything at hand to wash out the stomach in a case of poisoning, simply took a bit of soft indiarubber tube used for a gas-pipe, pared the end with a pair of scissors, and then pushed it into the stomach and washed the organ thoroughly out. So that practically in cases of poisoning, where there is no time to wait, you may possibly find on the premises a piece of india-rubber tube and a small funnel, which are all that you require for washing out the stomach.

The ordinary way of doing this is simply to pass the tube straight through the fauces, and the tube finds its way down without any more ado. It is advisable for a medical man to try this upon himself, because then he learns what the patient feels, and if you do this for yourselves you will probably notice that when the tube gets down to the level of the larynx a sudden fit of choking tends to come on, and you find the impulse to pull it up almost irresistible. This, of course, would defeat the object of the operation, and it may be resisted to a great extent if while practising you take two or three deep breaths, so as to get a sort of apnœa before you attempt to introduce the tube. You must not push it too hard, but when you feel you are going to choke, just stop for a little while, and breathe slowly and deeply; try to swallow all the time, and, as a rule, the tube goes down without much difficulty. Various things may be used to lubricate the tube. It may be dipped in simple water or glycerine, or it may be smeared with some ointment. Of all the substances that I have tried the most agreeable to me is cold cream; but all fats have this great disadvantage, that they rot the tubes, so that they perish very much sooner than when not treated with fat. When fat is employed they become quite hard and brittle, like the one I show you, so that they are rendered useless in a short time. When you have passed the tube down, you proceed to pour water into the stomach until it is full. The funnel I have is perhaps rather small; I generally use a larger one, but this small one will show you all that is necessary. When you have poured in as much as you think advisable, pinch the tube between the finger and thumb, so as to keep the tube full of water, and this is really one of the most important points, for so long as you keep the tube full you can make it act as a syphon. If you do not pinch the tube when you have finished injecting, the fluid in it runs back into the stomach, and the tube becomes empty, so that when you depress the funnel at the end of the tube it no longer acts as a syphon. If, however, you remember this precaution, your syphon acts perfectly, and will continue so acting until you have completely evacuated the stomach. When this is done you simply reverse the process; pour in some more water, and continue washing out the stomach until the water comes away clear. You should continue until the level of the water has descended below the level of the eye in the tube.

Emetics.—In cases where we wish to evacuate the stomach, it is sometimes easier to do so by means of an emetic. We have two classes of emetics: those which act upon the stomach directly, and are therefore called direct emetics, and those which act upon the nervous system, and are called indirect emetics. Now, in both cases the action of the emetic is due to stimulation of the centre in the medulla oblongata. In the case of the so-called direct emetics, it is really a reflex stimulation; in the case of the indirect emetics, it is probably to a considerable extent a direct stimulation; so that, you see, the use of the terms "direct" and "indirect" is likely to cause confusion. It is much better to speak of local and remote emetics. Local emetics act first on the stomach; remote emetics act first upon the central nervous system. Local emetics are such substances as cause local irritation of the stomach, and amongst the readiest emetics that we have is first of all tepid water. Hot water does not act readily as an emetic, cold water does not, but tepid water in large quantities does. The action of the water may be increased by the addition of two condiments that are often at hand: mustard or salt. If you add a quantity of salt to the water it acts as a pretty prompt emetic, and mustard added to the water has a similar action. The advantages of such emetics as these are that they are always at hand, and that they cause no depression whatever; they simply seem to wash out the stomach, and no more. Another drug which acts in a somewhat similar way is carbonate of ammonia, and this has a further action upon the system. It tends to stimulate the circulation and to prevent any depression which sickness or vomiting might occasion *per se*. Two other substances are prompt emetics: sulphate of zinc and sulphate of copper. The usual dose of carbonate of ammonia as an emetic is about 20 or 30 grains; the dose of sulphate of zinc is 10 to 30, and the dose of sulphate of copper is usually smaller: only about 5 to 10 grains. These emetics are frequently used in cases where we wish to get the stomach emptied quickly, as in cases of poisoning. There are three emetics which act chiefly through the central nervous system: apomorphine, emetine (which is the active principle of ipecacuanha), and tartar emetic (the action of which you cannot forget, for it is mentioned in the ordinary name of the drug). All these when introduced by subcutaneous injection or when injected directly into a vein cause vomiting promptly. Two of them at least can produce vomiting by their action on the nerve centres alone without any help from reflex action from the stomach. Antimony, when injected into the veins, will cause vomiting even after the stomach has been removed from the body, and its place supplied by a bladder; apomorphine produces vomiting after all the arteries going to the stomach have been ligatured, so that none of the drug can reach the stomach. It has been supposed, however, that their action is not exerted entirely upon the nerve centre for vomiting, but that they are partly excreted through the mucous membrane of the stomach, and by there irritating the ends of the gastric nerves give rise to reflex irritation of the vomiting centre.

Emetics are employed for a variety of purposes. First of all, they are used in order to empty the stomach of food which is objectionable either in quality or in quantity. If any of you have been to Rome you will have seen in the palace of the Cæsars a small room adjoining the banqueting hall; this is pointed out as being the place in which the Romans used to empty their stomachs when they had eaten so much that they could eat no more. Then, having emptied the stomach, they went back and finished the feast. In these Roman feasts the food was admirable in regard to quality, and was objectionable only in regard to quantity. Frequently it may be objectionable in regard to quality either because the substances eaten are bad in themselves, or because, after their ingestion into the stomach, they have undergone such changes as render them objectionable, so that when a person has taken something which has "disagreed with him," as it is termed, he feels sick and ready to vomit. The quickest way of easing him is simply to give him a lot of hot water, or mustard and water, and thus let his stomach be thoroughly cleared out.

Besides substances that are simply disagreeable from their quantity or quality, we may have actual metallic poisons swallowed, and then it is essential to clear the stomach out quickly. We may have, for example, some irritant poison taken such as arsenic, and then we either give plenty of hot water to clear it out or wash the stomach out with the stomach-pump. In other cases the poison is not of an irritant character, but just the reverse. A person may take laudanum, for example, and then you may find great difficulty in exciting vomiting by the use of an emetic, because the nerve centre through which the emetic ought to act is paralysed more or less completely by the laudanum. In such cases, although you may try, if you like, such emetics as sulphate of zinc or copper, yet, if no reaction occurs within a short time, you must have recourse to the stomach-pump. There is a certain advantage in each of these methods. The stomach-pump is better in so far that you may, perhaps, wash the stomach out more completely; the emetic is better in so far that the mere exertion of vomiting tends to arouse the patient from the soporose condition produced by the laudanum; but the actual procedure you decide upon will depend very much on what you have at hand at the time. In addition to their action in clearing out the contents of the stomach, emetics have an action in clearing out the contents of the respiratory tract, and they are frequently used for the purpose of clearing away a false membrane, as in cases of diphtheria or croup, or of clearing away a quantity of mucus which is accumulating in the respiratory passages, and which the ordinary efforts of coughing will not bring up. In vomiting there is a much more violent movement of the whole chest and of the abdomen, and sometimes a person will eject mucus and other things from the respiratory passages by vomiting when he cannot cough them up. We, therefore, use emetics in severe cases of bronchitis, where the respiratory passages are becoming clogged with mucus. As I mentioned before, the choice of an emetic depends upon the class of case. If there is a large accumulation of watery fluid and a weak circulation, you give carbonate of ammonia, but if the mucus is exceedingly thick and sticky, it may be advisable rather to choose such emetics as emetine, ipecacuanha, or apomorphine, which tend to render the mucus thinner and more easy to dislodge.

There are certain contra-indications to emetics, and one of those is the condition of pregnancy. If a woman is pregnant, it is quite possible that, during the efforts of vomiting, the contents of the uterus may be expelled as well as those of the stomach, so that one is chary of giving an emetic to a pregnant woman. You must be very careful indeed about giving emetics to persons who have any weak portion in the abdominal wall, because violent retching may give rise to hernia. In elderly persons also, with hard, brittle, atheromatous arteries, it is advisable to avoid emetics, if possible, because the violent straining might cause a blood-vessel to break, and thus bring on apoplexy.

In very many cases, instead of wishing to produce vomiting, we wish to avoid it, or we wish to arrest it. As I have already mentioned, the movements of vomiting are regulated by a centre in the medulla oblongata, and they consist practically of an extraordinarily deep inspiration, followed by a violent expiration with a closed glottis. The stomach is thus, as it were, squeezed between the muscles of the abdominal wall and the diaphragm, and its contents are ejected. But if the cardiac extremity of the stomach is contracted at the moment when the diaphragm and abdominal muscles contract, the contents of the stomach do not tend to pass out. The amount of pressure exerted upon the viscus is not sufficient to expel its contents in face of the resistance afforded by the contracted cardiac orifice, and these movements are termed retching. But if, at the same time that the diaphragm and abdominal muscles contract, the cardiac orifice opens, then a part, at least, of the contents of the stomach is evacuated, and so we get the result which is termed vomiting. The movements of the different muscles concerned in this act are co-ordinated in the medulla oblongata. The centre in the medulla is closely associated with the respiratory centre, and the movements of vomiting are, to a great extent, movements of respiration, but they are respiration and something more. The movement in vomiting is greater than even the greatest movements of inspiration or expiration as brought into play by the most violent coughing. The centre may be excited reflexly in many ways. It may be started from the brain, and we find that vomiting is very frequent when there is irritation of the meninges, as in tubercular meningitis, of the brain itself, as by a tumour, or where the sight, smell, or mere thought of something very disagreeable brings on vomiting. The stimulus to the vomiting centre in the medulla oblongata here proceeds from the cerebral lobes. The pharynx is a portion of the intestinal canal from which vomiting is readily excited, and vomiting may be brought on very easily by tickling the pharynx with a feather. Even when insufficient of itself to cause vomiting, tickling may be a very useful adjunct when an emetic you have already given is not acting. Supposing you have given to a patient a quantity of mustard and water to bring on vomiting, and the emetic is not acting, by then tickling the fauces with a feather, you may cause the emetic to act promptly. Irritation of the stomach itself will cause vomiting; irritation in the liver, as in cases of the passage of a gallstone; irritation of the ureter, as during the passage of a renal calculus; and irritation of the intestine. It should always be borne in mind that irritation or obstruction of the intestine will cause vomiting, and when you are called to a case of obstinate vomiting without any very apparent cause, always look to see if there is a hernia. Irritation of the bladder is said to cause vomiting occasionally, and irritation of the uterus is a very frequent cause of vomiting (Fig. 126).

Treatment of Vomiting.—Whenever we find vomiting, the first thing to do is, if possible, to discover the cause and remove it. In cases of cerebral disease it may be impossible to do this; in irritation of the pharynx we may soothe it by the local application of mucilaginous substances or of a little cocaine, which latter is frequently used also to stop the movements of

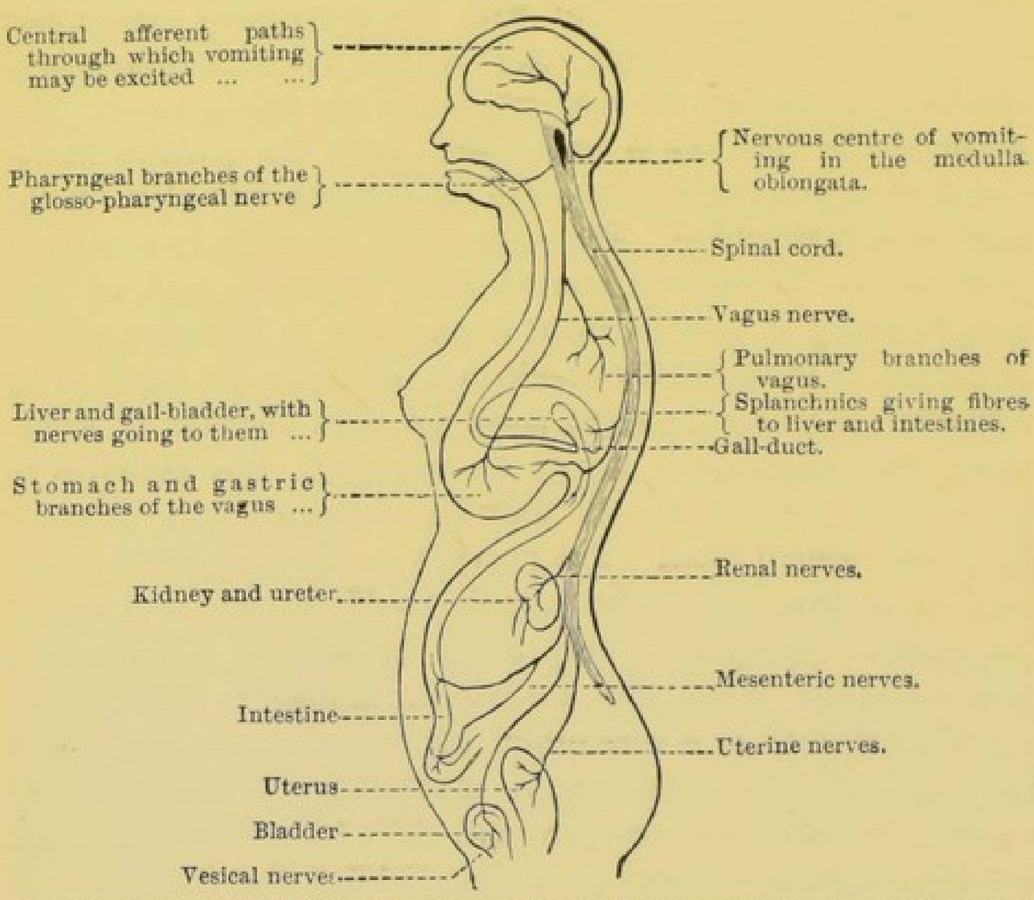

FIG. 126.—Diagram showing the afferent nerves by which the vomiting centre may be excited to action.

retching that frequently come on when one is anxious to examine the larynx. Where the irritation proceeds from something in the stomach itself, the best way to stop the vomiting is to evacuate the offending substance by washing out the stomach in one of the ways I have mentioned. Frequently, however, even after the irritant has been removed, there may be remaining an irritated condition of the mucous membrane of the stomach, with a desire to eject its contents, just as you find that irritation in the eye with a desire to rub it so as to remove an irritant may still remain after the grain of sand or of coal or other kind of dust which caused the irritation has been removed.

Where the mucous membrane is irritated you try to soothe it by means of something that will act as a local sedative or local anæsthetic. I mentioned to you before that the application of ice was a very useful local sedative and local anæsthetic to the skin, and the same application to the stomach tends to lessen its irritability also. Curiously enough, however, hot things have very much the same action as cold things, and very hot water will frequently be kept down when cold water cannot. I remember the case of the son of a medical friend of mine. He was apparently going to die, because he was quite unable to keep anything down. Ice had been tried, and all the ordinary sedatives for the stomach had been resorted to, but none of them had acted. In despair my friend asked me what he was to do. I said: "You had better try the opposite of what you have been doing hitherto. The plan you have been following has been unsuccessful, so you had better try something quite different. Give your little boy some milk as hot as ever he can take it." The advice was followed. The patient kept the milk down, and made a good recovery.

One thing to be remembered then is that hot things sometimes act as sedatives as well as cold. Cold things are most generally recommended. In violent vomiting one usually directs that everything should be iced, and also taken in small quantities; so that there should be no irritation from actual mechanical distension of the stomach.

Local sedatives such as cocaine are frequently very useful, and $\frac{1}{8}$ grain of cocaine will often stop vomiting, especially if combined with 10 or 15 minims of the tincture of belladonna. Opium and hydrocyanic acid are two other drugs that are very frequently used indeed. Hydrocyanic acid may be given in doses of 5 to 8 minims, and one is sometimes, I think, perhaps rather chary of giving it in larger doses on account of the risk that there is; opium may be given in various forms, and, curiously enough, you may occasionally get vomiting stopped by opium in one form when it is not stopped by another. You may sometimes find it may be stopped by some of the proprietary preparations when it does not yield readily to the ordinary tincture of opium of the Pharmacopœia.

Sea-sickness.—You are sure to be asked how to prevent the vomiting which is so distressing in sea-sickness. There are various ways of doing this, and the different plans depend upon the ideas that people have about the cause of sea-sickness. In regard to the pathology of the vomiting, some look upon it as gastric irritation due to the movements of the stomach on board ship, others as of central origin, due to reflex impressions from the eyes or to disturbance of the circulation in the vomiting centre in the medulla oblongata. In all probability these views are all correct for sea-sickness is of mixed origin and not due to one cause only. I think there is very little doubt that if, reverting to the habits of your infancy, you wear a tight bandage from your ensiform cartilage to below your umbilicus, it tends to prevent sea-sickness; at any rate, it certainly does make one more comfortable if the ship be rolling. The belt may be either of flannel or of linen, but the best is one of those long silk scarves called "Camarbands," wound tightly round, so as to keep the stomach pretty firmly in place. There is another fact that tends to support the view that sea-sickness is of cerebral origin. If the head is raised, people are much more apt to be sick, and once when I was coming across from France this was well impressed upon my mind. I had been travelling all night from Bordeaux, and could not sleep in the train. When I reached the steamer I felt very tired, and fell asleep immediately I got on board. There was a lady close to me, and she was terribly sick, so much so that I awoke. I went to her and asked her how she was feeling. She was quite unable to answer. I said, "Allow me to arrange your pillows." She could not say anything, but she made a feeble movement of the head. I arranged her pillows by taking every one away, and put her head flat down. She was not sick again until we reached Dover, when she raised her head to look after her luggage. If you put the head absolutely flat down it tends to prevent sea-sickness to a great extent. You can also greatly lessen the tendency to sea-sickness by giving drugs which will quiet the medullary centre; bromide of potassium is exceedingly useful for this purpose. The way in which I use it is this: I take with me in a little paper parcel about half a drachm or a drachm of bromide of potassium. When on board I go to the steward and say, "I want a bottle of soda-water and a large tumbler;" I throw in the bromide of potassium, shake it up, and drink it. This keeps one quiet and comfortable, at any rate while crossing the Channel. You need not be at all afraid of bromide of potassium, and you can keep up its action during a long voyage across the Atlantic; and you can push it so far that the patient becomes quite drowsy without doing him any harm whatever. Another drug that seems to be very useful is chloral. It has a similar action to that of bromide of potassium in lessening the irritability of the vomiting centre. There are many other drugs used in sea-sickness, but these, I think, are the most important. There is one point to be remembered about sea-sickness, and that is that there is often a good deal of bile in the stomach, and if you clear the bile out the patient is eased considerably. This is done by simply giving the patient a large draught of hot water; this he vomits, and thus the bile is well cleared out; afterwards you can give your remedies with some chance of success. In using the bromide of potassium you must remember that it is a salt, and, just like common salt, chloride of sodium, which is a powerful emetic, bromide is an emetic in itself if taken in too concentrated a form. A friend of mine, a doctor, was coming from Hamburg, and thought he would use bromide of potassium to prevent sea-sickness. He dissolved it in very little water indeed; it acted as a powerful emetic. Before he reached the mouth of the river he had brought up all the sedative to which he trusted to prevent the onset of sea-sickness; the vomiting caused by the bromide became continuous with that of sea-sickness, and he had a very bad passage indeed across the North Sea. You must remember that bromide of potassium, if it is to be given at all, must be given freely diluted.

In cases of obstinate vomiting you must, as I mentioned, always be careful to see that there is no hernia, as overlooking this may cost your patient's life. Sometimes the vomiting may depend upon the presence of irritating substances in the stomach and fermentation going on there. Creosote often tends to stop vomiting; so does iodine, say four or five drops of the liquor iodi. Both creosote and iodine appear to have an action, not merely in arresting fermentation, but in actually producing a sedative effect upon the stomach itself. In cases where the vomiting depends upon irritation in the uterus, you generally find that the recumbent position is useful, that bromide of potassium is useful, and that opium or chloral may also give relief by lessening the irritability in the nerve centres. Sometimes it may be necessary, however, to bring on premature labour in cases of obstinate vomiting in pregnancy, because the mother's life is endangered by her inability to keep down any nourishment.

Another simple method, which is occasionally useful, is that of counter-irritation. A blister or mustard leaf over the pit of the stomach sometimes tends to stop vomiting when drugs given internally do not succeed.

Carminatives.—Vomiting may sometimes be brought on by mechanical distension. The stomach gets tremendously dilated with flatus, and vomiting may occur. Sometimes if vomiting does not occur the flatus may give rise to great distress, great pain, and great dyspnœa. Drugs which tend to bring away flatus from the stomach are termed carminatives. Most of these are substances belonging to the class either of alcohols or of aromatic oils. They seem to have the power of tending to regulate the movements of the stomach, so that they relieve the distension of the stomach by lessening the contraction of the cardiac orifice. This under their influence dilates, and then, when the stomach contracts, the gas escapes. An action identical to that on the stomach is exerted by these substances on the intestines, and so they tend to cause an evacuation of wind, and to lessen any spasm and pain which may be due to an irregular or spasmodic contraction of the stomach or intestines. Carminatives are used then in order, first of all, to remove flatus, and, secondly, to lessen spasm. One of the most common is alcohol, but there is a disadvantage in using this, inasmuch as people are very apt to get into the way of using it too often. Another drug that is commonly employed is ether or spirit of ether, but this has a similar disadvantage. The aromatic oils are perhaps the most frequently used, and amongst those the favourite is oil of peppermint, given either alone or with a little bicarbonate of soda in the form of a tablet or a lozenge, or in the form of peppermint water. This tends to relieve flatus more powerfully than almost anything else. Dill-water is the carminative most frequently used for children. Small doses of chloroform along with aromatic oils evacuate flatus readily, and a very useful prescription is 10 minims of spirit of chloroform, 20 minims of compound tincture of cardamoms, and an ounce of water. In addition to this, you may give with advantage half a drachm or a drachm of aromatic spirit of ammonia; but if you mix the aromatic spirit of ammonia with compound tincture of cardamoms it destroys the bright, clear colour of this substance, so that perhaps it is best to add the sal volatile just before it is taken.

Flatus in the intestine may be removed partly by giving substances such as I have mentioned by the mouth, and partly by administering them by the rectum. Of all the drugs that tend to remove flatus from the intestine, the best that I know is asafœtida, but it has a most disagreeable smell. If you get a case of tympanitic distension of the abdomen, I do not know any drug that will relieve it like the enema asafœtidæ. Asafœtida given in the form of a pill is very efficacious in removing flatulence. It is a pity, I think, that the name of asafœtida pill has been used in the Pharmacopœia, because people know that asafœtida is a substance that has a most disagreeable smell. In the Pharmacopœia the compound pill contains galbanum, myrrh, and treacle. The old name of it in the London Pharmacopœia was not the pilula asafœtidæ. The framers of that work fixed, and, I think, fixed very wisely, upon another ingredient of the pill which was not so powerful as asafœtida, but still had an action of its own. It was called the galbanum pill, and it is advisable very often to prescribe it under the old name, because people think that asafœtida is a disagreeable, stinking thing, and that galbanum is an aromatic substance from Araby the blest. Thus they regard it as an agreeable thing, and they willingly take it when they would not think of taking an asafœtida pill.

Action of Drugs on the Intestines.—We may now pass on from the stomach to the intestines. The condition of the intestines may be affected by drugs which affect (1) the secretion, or (2) the movements, and some of the drugs which we use affect both. The secretion from the intestine is under the direction of various nerves, and if we cut all the nerves of the intestine we get a profuse secretion taking place, a secretion which may be imitated very readily by the injection into the intestine of various salines. For a long time there was a great discussion as to the mode of action of purgatives. Some said that they acted by increasing the rapidity of the intestinal movements, whereas others said that they increased the rapidity of secretion as well. If you go to the post-mortem room and look at the contents of the intestine, you will find that in the small intestine the fæcal matters are fluid. They may be fluid in the first part of the large intestine also, but as you advance along the colon they get harder and harder, until at the rectum they may be quite hard, forming regular fæcal masses. You can readily see then that if anything quickens the movements of the large intestine, so as to hurry onwards the more or less fluid contents of the stomach and small intestine, diarrhœa will result. You can also see that a substance which acts only upon the small intestine, however much it may accelerate its peristaltic movements, need not necessarily cause diarrhœa, because the watery contents which under these circumstances the small intestine would pour into the large intestine might remain in the first part of it long enough to allow the water to be absorbed, and consequently diarrhœa would not ensue.

There is one drug, bitartrate of potash, which has a very marked influence upon the secretion of the intestine and very little influence upon its movements, so much so that a large dose may be taken, and yet produce no purgative action. Yet we know that it has produced secretion into the intestine, because after it has been taken for awhile we hear a sort of splashing movement in the intestine, and we know from experiments on animals that this is due to a large secretion into the intestine. The method by which the action of drugs upon the secretion of the intestine has been determined is as follows:—You narcotise an animal and draw out of the abdomen a fair length of the intestine; put a ligature round it at four places, so as to make three loops of intestine separated from one another (Fig. 127). After all these loops are under precisely the same conditions, you inject with a hypodermic syringe some bitartrate of potash or sulphate of magnesia into one of the loops, say the middle

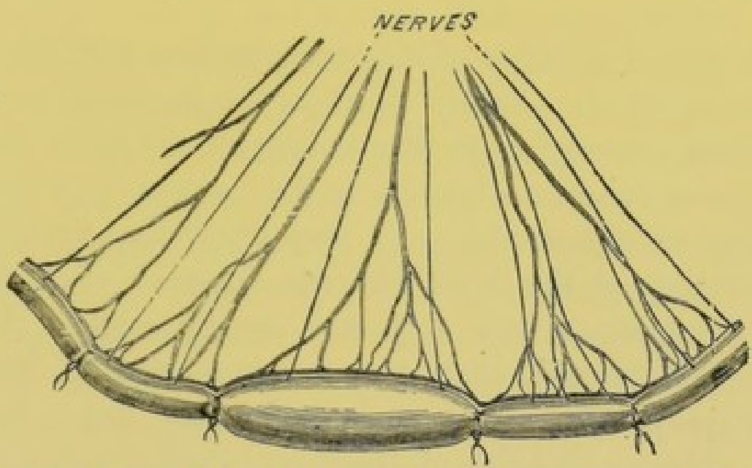

FIG. 127.—Diagram showing the effect of section of nerves on secretion from the intestine. The nerves going to the middle loop have been divided, and it is distended with the fluid secreted.

one. You then return the whole intestine into the abdomen, and after the lapse of four or five hours you kill the animal. Upon examining the loops you will find that in the middle loop, which has received the drug, there is an enormous accumulation of fluid. It is not the fluid that you injected, because that was only a small quantity; it is fluid secreted by the intestine under the stimulus of the purgative which you injected. No other factor can have had anything to do with it, as all the three loops of intestine were under precisely the same conditions. The reason for taking the middle loop is simply to show that the fluid has been derived from the vessels of the intestine, and has not gained entrance from the intestine above or below the ligature. Had an end loop been chosen, it might be objected that the ligature was not tied tightly enough, and so the fluid came in from other parts of the intestine. In consequence of this action of salines upon the secretion and the very slight influence they exert upon the movements of the intestine, we generally combine with salines something that will tend to act upon the movements also. We therefore prescribe with bitartrate of potash some jalap, and you will recognise that this combination is likely to prove an efficient purgative, because the bitartrate acts upon the secretion; the jalap acts upon the peristaltic movements. These two effects, however, might cause griping, and in order to prevent this you add a carminative, which, in the case of compound jalap powder, is powdered ginger.

In the case of sulphate of magnesia, we find that if it be given to a person just after he has risen in the morning, it will cause a free fluid evacuation in the course of an hour, but if the patient takes the dose when he is just awake, and lies still for an hour or so afterwards, it is very likely that he will not get an evacuation of the kind desired. Instead of a full, free, watery evacuation, and only one, as he ought, the probability is that he will have two or three scanty, insufficient, and perhaps painful, evacuations during the day. The reason is that a large quantity of the fluid which he has drunk, or which is secreted under the stimulus of the salt, is reabsorbed by the intestine, so that it does not pass out *en masse*. As the fluid which remains becomes more reduced and more concentrated, it gives rise to pain, whereas a single dose on rising would produce a free evacuation and no pain at all. This is frequently a great puzzle to patients. They tell you on some occasions that they have taken sulphate of magnesia, and it has had this disagreeable effect, whereas they say it used to suit them perfectly well. The probability is that when they took it previously they rose immediately afterwards, or took it after they had risen, instead of lying in bed for some time afterwards. So you see that in the case of salts you must expect that the effect will be much less powerful, and probably much less agreeable, if the patients lie for awhile after taking the medicine.

In order to prevent salines from failing in this way to do their duty, it is usual to combine with sulphate of magnesia and other salts some purgative which will act upon the movements of the intestine. Thus in common black draught we have sulphate of magnesia mixed with infusion of senna and some tincture of senna. The mistura sennæ co. of the British Pharmacopœia is simply the "old salts and senna" made up in a somewhat more agreeable way than formerly. The old-fashioned plan was simply to take a lot of salts, add it to infusion of senna, and sometimes a little sugar might be put into it, to try to delude the unfortunate children who had to take it into the idea that it was nice; this used to be administered by the cupful. It was a terrible business getting down a whole teacupful of this horrid mixture, and so the Pharmacopœia has lessened the quantity, but in order not to lessen the action the infusion of senna has been strengthened by putting in a little tincture of senna. In order to make the draught more agreeable, liquid extract of liquorice is added, which sweetens it very much better than sugar, and tends to cover the taste both of the senna and of the magnesia. To prevent the griping which the black draught would otherwise be apt to cause, some compound tincture of cardamoms is added to it, so that in the compound senna mixture we have all the proper ingredients of a prescription. The old rule for medicines was "curare, cito, tute, et jucunde;" that is, a medicine should

(1) Cure,
(2) Quickly,
(3) Safely,
(4) Pleasantly.

In the mist. sennæ co. there is (1) one thing to cure by acting upon the intestinal secretion, (2) another to help it by acting on the movements, (3) another to make 1 and 2 act safely by lessening flatus and lessening griping, and (4) another still to make the compound more agreeable.*

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* Sulphate of magnesium....	℥iv.	
Liq. extract of liquorice	℥i.	
Tincture of senna	℥ijss.	
Comp. tincture of cardamoms ...	℥iss.	
Infusion of senna	℥xv.	Dose, ℥i—℥iss.

LECTURE 22.

Action of drugs on intestine, *continued*—Constipation—Causes—Lack of indigestible residue in food—Nervous disturbance—Value of habit—Action of nicotine—Laxatives—Flatus to some extent aids evacuation—Sulphur—Compound liquorice powder—Cascara sagrada—Dinner pills—Time of administration—Composition—Purgatives—Sulphate of magnesium—Croton oil—Jalap—Scammony—Gamboge—Elaterium.

GENTLEMEN,

At the end of the last lecture we were discussing the action of drugs upon the intestine, and I mentioned to you that by means of drugs we were able to influence both the movements of the intestinal canal and the secretion of the mucous membrane lining it. I said that by means of drugs which would stimulate the peristaltic movements of the intestinal canal we could hurry on from the cæcum the fluid contents which were poured into it from the small intestine, and thus the evacuations would be of a fluid character; that, on the other hand, we were also able to stimulate the mucous membrane by means of such drugs as sulphate of magnesia, which would cause an increased secretion from the mucous membrane. But we must remember that such drugs as sulphate of magnesia do not cause merely increased secretion from the mucous membrane. In all probability before they have this effect they tend to limit absorption. The consequence of this is that if you give to a patient on rising in the morning a large dose of sulphate of magnesia, dissolved in water, it will apparently simply run through the intestinal canal, washing out a great part of its contents, but having very little action upon the body itself, excepting in so far as this scouring out is concerned. It does not seem to cause any great depression, it occasions no pain and no inconvenience, so that very many people are in the habit of taking on rising in the morning a small dose of saline for months or even years together, and without any apparent bad result. This clearing out is carried on to a greater extent by the patient visiting some saline springs, and drinking the water in larger quantities and more frequently than he would at home. During a course of this water, the bowels, even in patients who suffer much from constipation, are generally fairly free, but after the return home constipation again commences. So that a visit to those saline springs, such as Carlsbad, has a good influence for the time being, but does not tend to prevent the recurrence of constipation.

Constipation.—Constipation is one of the troubles that afflict civilised man. It cannot be called a disease; it is really more a natural condition of the bowels, which have not yet been accustomed in the process of evolution to the altered circumstances of life. I have very little doubt that the ancient Britons, who lived upon pig-nuts, acorns, and a lot of other such things, did not suffer very much from constipation, even though the acorns contained a good deal of tannin, because the quantity of indigestible food which they swallowed was quite sufficient to stimulate the bowels and produce one daily, or perhaps more than one daily, evacuation without the addition of any purgative. It sometimes happens, however, that this hard, indigestible food does tend to cause constipation, because the bowels, at first stimulated by it, after awhile lose their power and no longer react.

Constipation in ordinary people is generally due to the fact that the food they take has little or none of the stimulating qualities that ordinary diet would have in uncivilised countries. I daresay most of you remember from your school-days how Cæsar's troops used to carry about with them a bag of wheat and a small hand-mill. They ground their wheat in the hand-mill, and then they baked their bread of this coarse meal, but such meal is hard and gritty, and contains a great deal of indigestible residue, which would tend to keep the bowels of those taking it regularly active. Now-a-days we have wheat so finely ground that all the indigestible outer part is taken away from it, and we have nothing but the starchy interior of the wheat remaining;

so that we get fine white bread. I was once told by a man who had taken a great deal of interest in the Red Indians in America that their extermination was due to three influences: (1) to whisky, (2) to syphilis, and (3) to something which you would never suspect, viz., to fine white flour. The reason appears to be that the fine white flour causes constipation, and, I suppose, consequent upon this come typhlitis, peritonitis, and death. My informant did not go on to describe how the fine flour acted, but he said most positively that syphilis, whisky, and fine flour were the three causes of the extermination of the Red Indians.

Now you will find that fine white flour, either in the form of arrowroot or of Indian corn flour, or such materials, is generally looked upon as "binding"; that is to say, people have found by experience that the continued use of such substances renders the bowels more constipated. The consequence is that when we wish to get the bowels to act fairly and regularly we tell our patients to return more or less to a less civilised form of diet, and instead of taking fine white flour to take either whole meal bread or bread made of flour to which has been added a quantity of bran, such as various digestive biscuits, breads, cakes, and so on. Whole meal bread is very often sufficient to keep the bowels moving in persons who would otherwise suffer from constipation. The reason is simply that the bran, being quite indigestible, exercises a slight mechanical stimulation upon the mucous membrane of the intestinal canal as it passes down.

Most people object a good deal to the use of purgatives to keep the bowels open, and they would prefer to have something in their diet which would tend to keep them regular. You will find if you examine an ordinary diet table that most people take some laxative food. Some people take, for example, a fig before breakfast in the morning. The fig is a typical example of a purgative article of diet, because it contains a number of small round seeds which are absolutely indigestible. These act as a mechanical stimulus to the bowel. In addition to these, it contains a quantity of pulp, and the pulp consists partly of sugar and partly, though to a less extent, of neutral salts of vegetable acids. Both the salts and the sugar have a stimulant action of their own, and we have already discussed the powerful action of neutral salts upon secretion from the intestinal tube. Sugar appears to have an action of the same sort, with possibly also a certain stimulating effect upon the muscular fibre. At any rate in the fig we have two kinds of stimuli resembling those exercised by the compound jalap powder, which we discussed at the end of the last lecture, viz., something that will stimulate the movements of the intestine—viz., the mechanical stimulation exerted by the seeds—and something that will stimulate the mucous membrane—viz., the sugar and the neutral salts contained in the pulp of the fig. A fig eaten before breakfast is frequently used as a laxative, while other people prefer to eat it at night. In place of a fig many people eat raw apples; others eat tomatoes. In the raw apple and the tomato we have a feebler mechanical stimulus, but we have probably a more efficient secretory stimulus in the tomato, from the amount of neutral salts contained in it.

A simple draught of water, taken in the morning or the last thing on going to bed at night, will sometimes act as a laxative by keeping the fæces moister than they would otherwise be. The water may be cold or quite hot; either is a useful laxative. Again, when we come to examine the breakfast-table we find there, as a rule, laxatives. We find, for example, marmalade, which has, just like the fig, a threefold stimulating action. There is, first, the mechanical stimulus from the small pieces of orange-peel contained in the marmalade, which are almost entirely indigestible, and which, on passing through the intestine, exercise a mechanical stimulating action upon it; then we have, secondly, the sugar, and, thirdly, the neutral salts, all of them having a stimulating action upon the secretory apparatus in the intestine. In place of marmalade we sometimes find jams, such as strawberry or raspberry jam, and these also contain the threefold stimulus. In fruit jellies we have no mechanical stimuli, but we have sugars and neutral salts; in honey or golden syrup, which are frequently used as substitutes for marmalade or jams, we find only the effect of the sugar, but one takes much more sugar in these substances than in jam or jelly, and so they have a pretty powerful laxative action.

Now, old-fashioned black treacle had even a more stimulating action upon the bowel than syrup has, and it was a very useful laxative. In the case of children you will find that golden syrup or jams are often sufficient to relax the bowels, and children take them very readily; but in cases of obstinate constipation in children you may possibly find that if you get the black treacle, which they will take readily enough after a short time, it will prove a more efficient purgative than any of the newer forms of syrup. Indeed, treacle will act, not only when given by itself spread upon bread or with oatmeal porridge, but also when baked with bread, so that gingerbread acts as a laxative, more especially in children, although it will act in grown-up people also. We have in the Pharmacopœia manna, which is an instance of another form of sugar acting as a laxative, but it is not much used. You may, however, have recourse to it now and again for children. One of the reasons, I fancy, that it is not much used is that medical students rarely have an opportunity of seeing it. At the beginning of each session the drawer containing manna in the museum of this Hospital is carefully replenished, but, as a rule, I think it is empty before the first week is over, and it is only the first comers that see, and still more only the first comers that taste, the manna. Men do not seem to become acquainted with it unless they are able to handle and taste it, and as it has been found that the drawer cannot be kept full however often it is replenished, the attempt has been given up in despair. At dinner you very often have laxatives also. For example, a favourite dish is stewed prunes, which are often taken with arrowroot, or Indian cornflour, or ground rice, or those other substances that I have mentioned as being very digestible, and as containing no irritating residue. So that by the addition of syrups, jams, jellies, stewed prunes, or stewed fruits of various sorts to farinaceous forms of food the effect that they would otherwise have in producing constipation may be counteracted. Stewed apples or baked apples are also a favourite form of using fruit for laxative purposes. There is one plan of combining a laxative of some stronger character with stewed prunes which is sometimes very useful, and many people will use it when they object to the use of a definite purgative. Take a few senna leaves or pods, put them in a little muslin bag, tie up the end, and drop it into the pan in which prunes are stewing. The active principle of the senna (cathartic acid) dissolves, and so both the prunes and their juice acquire a marked laxative action, much stronger than they would otherwise possess. Many people will take this and be satisfied, because they think they are not taking medicine, and they seem to draw quite a curious distinction between taking senna in this way and taking it in the form of a powder or an extract.

One of the commonest causes of constipation is nervous disturbance. Many people, if they get into the habit of doing a thing at one time, will continue to do it regularly day after day, but if the habit is broken they find a difficulty in resuming it. We see this markedly in the case of sleep. If a person goes to bed regularly at eleven each night, for example, he may wake regularly each morning at six or seven, but if he stays up late one night and lies late in bed next morning, he very likely will break his habit of sleeping at a given time and of waking at a given time. Occasionally you will find that if a man has to get up quite early to catch a train on one morning, the next morning he will also wake at the same hour, although there is no reason whatever for his doing so. In the same way, the habit of going to the closet regularly is of great importance in keeping the bowels open. Unfortunately this habit is very often broken by hurry. For example, men who are going to business in the morning, finding that they are a few minutes late with their breakfast, do not attempt to go to the closet after breakfast. Sometimes you will find, especially in the case of ladies, that the habit is broken either because it is not convenient to go at a regular time, or because some one else is occupying the closet, or they do not like to go from motives of modesty because a number of other people are about. Now, in cases where they cannot go in the morning, you should try to induce them to go at night, and one of the best means of ensuring regularity in the action of the bowels is to tell your patients to go at a definite hour *by the watch* every day to the closet, whether they wish to go or not. In this way, by soliciting nature the tendency of the bowels to act at regular times is ensured. Constipation is such a common thing that you will in some obstinate cases be almost bothered out of your lives by patients who do not react to this or to that medicine, and this simple method of making them go regularly is exceedingly useful. One of the reasons for people going *after* meals is this: that when food is taken into the stomach it acts as a stimulus, not only to the stomach itself, but to the intestines, so that a certain amount of peristaltic action is induced in the intestines by the mere introduction of food into the stomach. When food is put into the stomach, it does not stimulate the stomach only to movement and secretion: it stimulates also the colon and rectum to move and evacuate the material that is lying in them. In health this stimulus does not act after each meal; it acts only once in the day, when there has been a sufficient amount of material accumulated in the descending colon and in the rectum to allow of an evacuation. As we shall see by-and-by, there is a form of diarrhœa in which a desire to go to the closet comes on after every meal. When a person goes in the morning, the desire to evacuate is stimulated by the introduction of the breakfast into the stomach, and, therefore, a favourite time for evacuation is immediately after breakfast.

There is one drug that has a very powerful effect upon the intestines, viz., nicotine, and a very small quantity of nicotine in the form of tobacco smoke will frequently stimulate the bowels so as to cause a regular action, and you will find that a great many men take a pipe after breakfast for this purpose.

In cases where the patients suffer much from piles or prolapsus, it is advisable to get them to go to the closet not in the morning, but at night, because if they go in the morning the piles or prolapsed bowel are apt to remain down, and to give trouble during the day; whereas if the patients go at night the prolapsus or piles can be returned into the rectum, they lie down in bed, and there is no further discomfort.

Laxatives.—You will sometimes find that these simple remedies will not succeed, and you must then have recourse to something more stimulating, something that will induce the bowels to act regularly. The substances that simply cause a more frequent, more full, or more liquid, but still a well-formed evacuation are termed "laxatives." The substances which I have mentioned—honey, syrups, and so on—are classed as laxatives; so is manna, and so are tamarinds, which are just another form of giving vegetable pulp. But there are various other drugs which are very much used, and one of the commonest, I suppose, is sulphur in small doses. This used to be given to children in the form of sulphur, treacle, and cream of tartar. These were added together and made into a smeary mess, which the child was obliged to take. The framers of the British Pharmacopœia thought this was not quite the proper way of administering sulphur to patients; so, to make the mixture more elegant, the sulphur and cream of tartar, which are the essential ingredients, were mixed up with syrup of oranges and tragacanth instead of treacle. This confection of sulphur is exceedingly useful, and may be given in doses of a teaspoonful at night; but Sir Alfred Garrod found, as many others have found, that the confection of sulphur got hard by keeping, and then he advised his patients just to break a bit of this solid confection off and to take that. Then it occurred to him that it would be useful to have it in the form of a lozenge, and so, at his suggestion, sulphur lozenges have been introduced into the Pharmacopœia. These, you will see, contain very nearly all the ingredients of the confection of sulphur, but made up in the form of lozenges, each containing 5 grains of sulphur. These, I believe, are now manufactured by the ton, and are sold in very large quantities indeed. It is quite curious what an effect even a small dose of sulphur will have. Five grains of sulphur, you would say, could have little or no action upon the bowel, and yet they undoubtedly have. Probably the way in which this small dose of sulphur acts is that it is converted into a sulphide which has a pretty powerful stimulating action upon the intestine, so that even one lozenge is sometimes quite sufficient to keep up the regular action of the bowels. Now, when people are taking sulphur even in such small quantity, it is frequently noticed that the gases discharged from the intestine contain sulphuretted hydrogen, and the presence of this in the intestine seems not only to have a stimulating action upon the bowels, but to cause a more forcible expulsion of fæcal matter. Probably the mere presence of the gas in the intestine is useful. I daresay you remember using popguns when you were children, and how you had a large hollow tube with a pellet at each end. If by any chance the air got out from between the pellets, it was difficult to get one of them out; whereas if the air were confined in the space between the pellets, when the ramrod was pushed down quickly the further one was ejected with great force. When gas is present in the intestine, the passage of one fæcal mass down the intestine seems to force the one in front of it onwards, much as in the popgun, and thus to aid the action of the bowels, and I think that it is probably on account of this that sulphur is so useful. We find that sulphur is an ingredient not only of the sulphur lozenge and of the confection of sulphur, but of another preparation that is more commonly used in the ordinary household.

A vast number of patients, instead of asking their medical adviser what they are to take, prescribe for themselves, and what they very often do prescribe is the compound liquorice powder. Now you will find that this contains a little sulphur, which greatly adds to its utility. The common use of compound liquorice powder is owing, I think, a good deal to its name. People think that liquorice is the laxative, and they consider it to be a mild sort of thing which cannot do them harm, and they go on taking it; but the active part of compound liquorice powder is really the senna it contains. Then, in addition to this, the compound liquorice powder contains some fennel. The fennel was excluded from the previous edition of the Pharmacopœia; it was retained, however, in the German Pharmacopœia; and then on investigation, before the new edition of the Pharmacopœia came out, it was found that hardly anybody would take the English liquorice powder, and that everybody wanted the German liquorice powder, because the fennel in the powder seemed to have the effect of neutralising any griping tendency of the senna, and thus of making the powder much more agreeable to take. Compound liquorice powder is usually taken in a dose of about a teaspoonful, more or less, at night or in the morning simply stirred up in a little water.

The next substance that is most frequently used as a laxative is cascara sagrada, which is a kind of buckthorn. We had formerly various species of rhamnus: the rhamnus catharticus, and rhamnus frangula; and now we have the rhamnus purshiana, or "cascara sagrada," which is simply the Spanish for sacred bark, because this bark was supposed to have some sacred quality. Cascara sagrada has now come into such common use as to have displaced most of the other laxatives, and is made up in various forms. For example, it is taken in the form of liquid extract in doses of half a drachm or a drachm, usually at night, because when taken in the morning it does not act sufficiently quickly. It may be given alone or in combination with various aromatics and other substances to make it more pleasant. You may use along with it some chloroform water or spirit of chloroform to sweeten it, and various essential oils to render it more agreeable. It may be given also in the form of a solid extract in 1 or 2 grains, either as a pill or as a tabloid. I am not quite certain, however, that the tabloids or pills act quite so well as the liquid extract. It would appear, I think, that the active principle is rather easily decomposed, and that the heat to which it is subjected during evaporation into a solid form tends to lessen its activity. Moreover, there is one thing to be noted in prescribing the cascara sagrada, and that is that different chemists do not always supply the same substance. The agent of one of the wholesale houses explained this to me. The cascara sagrada grows, I believe, to a great extent in New Mexico. Various houses have sent out their agents to this district in order to collect the bark of the cascara sagrada, but a number of them are quite willing to accept barks obtained from different species of rhamnus, not entirely from the rhamnus purshiana. These other barks, however, are not quite so active as the rhamnus purshiana, and in consequence of this the liquid extract of these barks made by the less careful chemists is not so active or so efficient as that made by the more careful chemists. If you find when you are in practice that your patients complain that the cascara sagrada is not acting, and that they are not getting the results they would expect, then try the liquid extract from some other firm.

Dinner Pills.—Cascara and senna are the pharmacopœial drugs most commonly used in the treatment of habitual constipation by patients themselves, although immense quantities of proprietary pills are used besides. When these do not succeed patients often come to the doctor for some pill, and you may prescribe pills in various ways. You may either give a pill the last thing at night before going to bed, so that the patient's bowels may be stimulated during the hours of rest, or you may give it just before the last meal of the day, so that the stimulating effect upon the bowels which I have told you is produced by the introduction of food into the stomach may be increased. An old friend of mine made what I thought a very sensible remark. He said he always gave his dinner pill five minutes' start of his dinner, because he thought that if he put the little dinner pill into the stomach just after dinner it would wander about inside amongst the food and would not exactly know what to do, whereas if he put it into the empty stomach there was nothing for it to do but to go round and see what effect it could have upon the stomach, and in this way it would possibly get through into the intestine before the food had filled the stomach. He said that taken before it acted a good deal better than taken after. You will find that my old friend's notions are not altogether universally adopted, because many doctors give the dinner pill either with or after the dinner, but you may as well bear his remarks in mind, and if you find patients do not react to a pill taken after dinner just let them try it a little before. In place of giving a pretty strong stimulus to the stomach and bowels either the last thing at night or at the last meal of the day, you may give them two or three jogs during the day by dividing a dinner pill into two or three parts and letting the patient have one at breakfast, lunch, and dinner, as, for instance, a small quantity, say, of aloine, one-third of a grain being often quite sufficient. In some cases the patient prefers to take the small pill at breakfast instead of at dinner, because the time that food takes to traverse the intestine varies in different individuals, and a pill taken at breakfast sometimes causes an evacuation at a time that is more convenient for your patient than one taken at dinner.

Dinner pills vary a good deal in composition, but there is one drug that is present in almost every one of them, and you can readily enough see why. I have already told you that in the cæcum all the contents of the bowel are liquid, that as they move gradually along they become more and more solid until they reach the rectum, but you can readily understand that they might stop at the sigmoid or at the rectum, and thus there would be no evacuation, and so if you wish to ensure an evacuation it is advisable to get a drug that will act more especially upon the lower part of the intestine. Now, aloes is said to have a peculiar power of stimulating the lower part of the large intestine, and so you will find that aloes forms an ingredient in almost every purgative pill. One of the commonest pills used, both by patients on their own account and also by doctors, is the compound rhubarb pill. This contains aloes, it also contains some rhubarb, and these are its two essential constituents; some oil of peppermint, however, is added in order to lessen any griping pain. Occasionally rhubarb and aloes are not sufficient, and then one has recourse frequently to the compound colocynth pill. Here also we find aloes, and besides this there are colocynth, sulphate of potassium, and scammony, all of which have a pretty powerful stimulating action upon the intestine. The pill also contains some oil of cloves to lessen the griping that colocynth causes in a number of patients, but frequently this is not sufficient, and we have also a pill containing hyoscyamus, in which there are two parts of compound colocynth pill and one of extract of hyoscyamus. A very useful pill is frequently made by combining the two pills I have just mentioned, say 2 grains of the compound colocynth pill, 2 grains of compound rhubarb pill, and 1 grain of extract of hyoscyamus. Sometimes you may find that this is too much, and you may then give half the quantity: 1 grain of compound rhubarb pill, 1 grain of compound colocynth pill, and half a grain of extract of hyoscyamus. This is one of the most useful pills I know, and the same old friend of whom I was speaking told me that he took this pill every night for 40 years without missing once, and he found that it answered all that time. This experience of his enables us to at once meet a difficulty which is frequently brought before us by patients. They say: "Well, doctor, it is not a natural thing that I should use those pills, and they are sure to lose their action;" you say: "They are not sure to lose their action, because there is a case in which a man took the same kind of pill for 40 years, and it still continued to act perfectly." Then, as to its not being a natural thing to take a purgative, you say: "It is not natural for you to require a pill, but neither is it natural that you should keep a cook. If you discard your cook and eat all your food without cooking at all, the probability is that you would not want a dinner pill or a pill of any other kind; but if you keep a cook who softens all the hard things and carefully takes away all the indigestible parts which would act as a stimulant to the intestine, you must put something into your intestine that will aid its action, and the best way of doing this is to take a dinner pill." This will often convince your patients and render them more amenable to reason. Then there is one other drug, a simple laxative, that is exceedingly useful. It is one of the very best, but as a rule patients will not take it, but where they will take it it is a pleasant thing, and that is castor oil. A small dose of castor oil, say 20 to 60 minims every morning, will sometimes keep the bowels acting beautifully when other drugs have failed. It may be given in brandy and water or brandy and peppermint water without the patient tasting it (*vide* p. 247).

Purgatives.—In cases where you wish to stimulate the bowel something more than to gentle action, and desire to clear out some accumulation, you give such drugs as those which I have mentioned, but give them in larger doses. In larger doses they act not merely as "laxatives," but as "simple purgatives;" that is to say, instead of the motion being "formed" it is more frequently loose and even watery. The substances which have this effect are termed "simple purgatives."

The so-called drastic purgatives might be serviceable in these cases, but these as a rule form a class by themselves. Their action is chiefly confined to the muscular fibre of the intestine generally, and they have not the same power of causing secretion that the salines have. For example, in the experiments I made a number of years ago on the action of various drugs upon the intestinal movements and secretion I found that while the injection of a neutral salt, such as sulphate of magnesia, into a loop of intestine, produced an enormous distension of the loop, the injection of croton oil into a similar loop caused almost no secretion and no distension of the bowel, but on slitting the bowel open there was a marked difference between the appearance of the mucous membrane in the two cases. After the injection of sulphate of magnesia the mucous membrane was as a rule pale; there was no injection whatever; but after the injection of croton oil red vessels were seen ramifying all over the surface of the intestine, and it was evidently in a state of inflammation. Now, most of the drastic purgatives have this power of irritating the bowel. Amongst them we have croton oil as one of the most marked. The dose of croton oil is a very small one, and this is one of the test questions at many examinations. The examination of medical students is not to find out what they do not know, but to find out what they do know, and ascertain whether they know enough to pass safely. If a man is not safe he is rejected, for otherwise he might kill his patients; and one of the forms in which he is apt to show himself unsafe is a tendency which he exhibits to give too large doses of very powerful drugs. Croton oil is one of these. The dose of croton oil is only about half a minim to 1 minim. You may give up to 2 minims, but that is a very powerful dose. Many years ago some naughty schoolboys got a whole holiday, and in a very wrong way indeed. Some of the boys in the house put 1 drop of croton oil on a piece of bread which was then carefully buttered. The unfortunate master ate it unsuspectingly, and he was unable to take part in the duties of the school for a whole day. It is to be borne in mind then that 1 drop is quite sufficient, as a rule, to act as a powerful purgative. If you give more, you run a certain risk. At the same time a large dose of croton oil has sometimes been taken without any bad results. I was asked a number of years ago to see the friend of a nurse. The nurse brought her friend immediately after she had swallowed 20 drops of croton oil by mistake for laudanum. She at once recognised what she had done, because she knew she had only two bottles on the mantel-shelf, and the burning feeling as the croton oil went down her throat warned her at once that she had swallowed something else than laudanum. I gave her a quantity of gruel, into which I put some mustard, so as to make it a prompt emetic; it was returned almost at once, and I gave her some more gruel, and then a third portion, and the consequence was, the whole of the croton oil was washed out by the gruel, and there was no further result from it. I think she had one motion afterwards, and even that was not a very loose one; so we must assume that the croton oil was entirely washed out by the gruel. If she had not taken this simple antidote so quickly after her mistake she would almost certainly have got inflammation of the stomach and intestines and very likely have died in consequence.

Amongst other drastic purgatives, we have jalap and scammony. Further we have some other drugs which may be classed partly as drastic and partly as hydragogues and purgatives, because sometimes they cause not merely violent evacuations, but very watery evacuations as well. Drastic cathartics are used chiefly when we wish to clear the bowels thoroughly out, and sometimes when we wish to cause what is termed a "revulsion" in cases where the head is congested. Where we think that there is too much blood flowing to the brain, we may use drastic purgatives, so as to cause more blood to come to the bowels, and thus relieve the brain by bleeding the man, as it were, into the vessels of his own abdomen. As I mentioned to you before, the abdominal veins are capable of containing an enormous quantity of blood. If you tie the portal vein in an animal, in a very short time the animal will die, with all the symptoms of being bled to death, and although this phenomenon is probably a somewhat complicated one and is not entirely due to the actual bleeding into the abdominal veins, yet in all probability the bleeding into the abdominal veins is a powerful factor in the result.

In cases where we wish to remove a large quantity of fluid from the body, as in patients suffering from dropsy, we give a substance which will produce a large secretion of fluid in the intestine. A good example of a hydragogue cathartic is one already mentioned, compound jalap powder, and in this we have a mixture of a drastic with a hydragogue, or rather, I should say, with a saline; and drastic and saline purgatives together form a powerful hydragogue. The jalap is a drastic purgative, the bitartrate of potash is a saline purgative, and the two together will remove water from the body very quickly. But, in addition to the jalap powder, we may employ also two other hydragogue cathartics, viz., elaterium and gamboge. Gamboge is not very much used, but elaterium is employed a good deal, and it is an exceedingly powerful hydragogue cathartic. It causes a large quantity of fluid to be secreted and to be quickly evacuated. Now, elaterium is the sediment from the juice of the squirting cucumber. The fruit of this species of cucumber when it is ripe breaks off from its stalk, and then the whole of its contents squirt out at the place where the stalk was formerly attached. When the contents of such a cucumber are put into a dish and allowed to settle, a sediment falls, which forms a thin whitish or grey plate marked with the irregularity of the tile on which it has been dried. This is elaterium, and it is such an innocent-looking thing that men are very apt to be caught about the dose of it. The dose of this innocent-looking stuff is only $\frac{1}{16}$th to $\frac{1}{2}$ a grain, and I want you to remember this, because it is one of the questions on which you might be rejected, simply because you did not know the exact dose to prescribe.

It is a dangerous substance, and if you occasionally have to use it, you must not give an overdose. The sediment is not always of the same composition; sometimes it is more active, sometimes less active; and so in order to get a substance upon which one could rely the active portion of it has been introduced into the Pharmacopœia under the name of elaterine. The active principle is obtained by extracting the elaterium with chloroform and then precipitating with ether. The dose of elaterine, as you would quite naturally imagine, is smaller still; it is only $\frac{1}{40}$th to $\frac{1}{10}$th of a grain.

LECTURE 23.

Hydragogue cathartics, *continued*—Use of purgatives—Opium as a purgative—Belladonna as a purgative—Gouty constipation—Constipation a cause of fever—Effect of purging upon arterial tension—Dangers of straining at stool—Glycerine enemata—Ordinary enemata—Method of washing out upper part of large intestine—Nutritive enemata—Carminative enemata—After-effect of purgatives—Hæmorrhoids and their treatment—Mechanics of defæcation—Diarrhœa—Causes—Treatment.

GENTLEMEN,

At the end of last lecture we were discussing the action of various hydragogue cathartics, and I mentioned that one of the most powerful was elaterium, and that, in order to obtain a constant preparation of this drug, the active principle, viz., elaterine, had been introduced into the Pharmacopœia. The dose of elaterine is so very small that it is difficult to weigh it out except by means of a delicate chemical balance, and the chemical balances which would weigh it with any amount of exactitude are so rarely to be found in druggists' shops that, in order to make a more convenient form for dispensing, elaterine has been mixed up as a powder with sugar and milk and put into the Pharmacopœia under the name of pulvis elaterini compositus. This powder contains one part of elaterine mixed with 39 parts of sugar of milk; thus its bulk is greatly increased, and it is rendered more easy to dispense. The dose of this powder is half a grain to 5 grains. I daresay you have noticed that I have as yet not bothered you much about doses, but there are some drugs the exact doses of which you must know before you go up for examination. Elaterium, elaterine, and the compound elaterine powder are examples of this, as is also croton oil. Another hydragogue cathartic, which I think I mentioned in passing, is gamboge. This is not used to the same extent as the others; it is necessary nevertheless that you should remember its dose. The dose of gamboge is 1 to 4 grains. Gamboge is said to be a drastic as well as a hydragogue purgative, but it has not the same power of causing irritation and congestion in the intestinal tube that croton oil has; it lies much nearer the hydragogues than the drastics.

Uses of Purgatives.—We may come now to the uses of aperients. First of all, you may wish to remove fæcal substances lying in the intestine. Not only do these give rise to disturbances mechanically, but they may do so by giving rise to products of decomposition which are absorbed and which act as poisons to the organism. We all know what a general dread is felt of sewer gas, and whenever anybody gets ill in a house one always inquires: "Are the drains in order?" but there are many people who carry about a cesspool inside them. They do not get their bowels opened as they ought to do, the fæcal masses undergo decomposition in their intestines, and then they wonder what is the matter with them. If you have to treat such patients, get their bowels open thoroughly well, and they will feel much the better for it. Frequently you may notice that patients who complain of feeling weak and low, of being unable to attend to anything, of having no interest in life, and of feeling generally utterly miserable, will become perfectly different people if you simply clear their bowels thoroughly out. One of the best ways of doing this is by means of a mercurial purgative overnight and a black draught the next morning. The action of mercurial purgatives we must consider when we come to discuss the effect of drugs upon the liver, but keeping the bowels cleared out has an extraordinary effect upon the well-being of an individual. We do not know to what extent the events of history may have depended on the condition of the bowels in kings and generals. You know that in the time of Louis XIV there was a perfect mania for taking enemata, and Louis and some of his courtiers had their bowels opened many times a day by means of enemata. This no doubt tended to prevent the effects of overeating and overdrinking. Many people who eat and drink too much would be a great deal worse off if it were not that their bowels are kept rather loose. You will notice, I think, that in people who are accustomed to drink more alcohol than is good for them the bowels almost always tend to be loose. Oddly enough, you find the same thing in people who take opium. Small doses of opium constipate, but you rarely or never find the bowels habitually constipated in an opium-eater, and generally his bowels tend to become rather loose. Opium when injected into the veins is one of the most powerful purgatives that I know of. When I was working in the laboratory of Professor Ludwig at Leipzig, it was his custom invariably to narcotise the animals before operation by means of an injection of opium into the veins. A hypodermic needle was just stuck into the vein, and a drachm or so of laudanum was injected, but before the injection was given preparation was made for the purgative action of the opium by placing a large quantity of tow close to the anus of the animal. This preparation was very necessary, because in less than half a minute after the injection of the opium into the vein the whole of the intestinal canal seemed to be thrown into most violent action, and the whole of its contents were shot out. This is a sort of action that one would never have expected from the opium. Sometimes you find that opium has a purgative action, even in moderate doses, on your patients. I think that this action is more generally induced in one class of patient where the ordinary drugs do not act. You will find, in some women especially, that the nervous system of the bowel seems to be so delicately balanced that it leans always to one side or other, and they either suffer from diarrhœa or constipation. If they are constipated you give them a small dose of an aperient, but, to your disgust and to theirs also, you find that the small dose of an aperient has acted as a powerful purgative, and in such cases minute doses of opium may sometimes put the matter right.

I have already mentioned to you that the nervous system of the bowel contains two distinct sets of nerves, inhibitory and stimulating, so that you have these two varieties of nerves acting against one another; and the question whether the bowel remains quiet or becomes active, and whether the motions are hard or become loose, depends upon not so much actual stimulation of either set of nerves as upon the preponderance of one set of nerves over the other.

You can readily enough see that if the nerves should be, from the nature of the patient, very nearly equal, a very slight stimulus might just turn the balance. Occasionally I have succeeded in curing obstinate constipation in such cases without any purgatives at all by giving belladonna, or by giving nux vomica, or by combining the two together. Many years ago a paper was published on the action of belladonna as a purgative, and the dose, if I remember rightly, was $\frac{1}{32}$nd of a grain of the extract of belladonna. I tried it, but I did not try it in the proper dose, and I did not get good results. My results were negative, and I was inclined to think that there was nothing in it at all; this, I believe, was simply due to my not having followed the directions. In very minute doses, I think belladonna sometimes does turn the balance, and occasionally I have obtained good results from belladonna or hyoscyamus combined with nux vomica. In cases of this sort, inasmuch as the individual peculiarity of the patient may determine the action of the drug, the best way is to begin with quite small doses and gradually work up, because if you overshoot the dose the chances are, you will not get the benefit that you desire. I believe it is in such cases as these that homœopathic practitioners have a great advantage, because they begin with such exceedingly minute doses that they are not likely to overdo the effect of the drug, and so they may work up and get the bowels to act regularly.

I have found also that in the case of people belonging to gouty families obstinate constipation may exist, which yields to a powerful purgative, and then returns worse than before. In such cases the administration of salicylate of soda will tend to keep the bowels regular without any purgative whatever. By treating the general gouty state you get the local condition of the bowels improved. Then, curiously enough, meat in some people seems to have the power of causing constipation. It is not merely that the patient who takes meat eats less vegetables than before. I suppose that in some way proteids lessen the peristalsis of the bowel, and so have a constipating effect; for sometimes when a patient cuts off meat entirely the bowels become regular, even though he takes no more vegetables than before.

Another statement has been made to me by a patient, but it rests upon his authority, and I really cannot tell you whether it is right or not. I have no doubt it is correct so far as the individual himself is concerned, but I do not think that you can take it as a general rule. He wrote to me to say that he had given up bread entirely, living upon meat, eggs, and vegetables, and that since he had cut off bread his bowels had become quite regular. I should not think this was a general condition, but it is just possible that it may occur in some individuals.

Now, by clearing away the waste products from within the body you improve the general condition, and you very often improve the appetite, and no wonder, for you cannot expect any one who is stuffed up with the products of waste to have an appetite for food. The waste products, however, have another effect. Sometimes a man who usually goes regularly to the closet is prevented by some occurrence, such as the necessity of catching a train, from going at the usual time. In consequence of this, he begins to feel a sensation of weight in the abdomen, and not unlikely a little later a sensation of distinct weight in the head comes on, followed by a headache. Although the bowels are not opened, these effects pass off, and he may remain without any motion for several days without feeling any more discomfort. But if the bowels are not opened at the end of three or four days, the symptoms are apt to return again and become more severe. Now, along with the headache, you may find irritability of temper, and the administration of a purgative will not only clear away the discomfort in the abdomen, but will clear away the heaviness in the head, and frequently remove also the irritability of temper. At the same time, it seems to restore the power of attention which sometimes is lost at the time when the head becomes uncomfortable, even although no distinct headache may be present. Sleeplessness is another condition which is not unfrequently consequent upon constipation. There are many patients who are quite sleepless if their bowels are constipated, but who get sleep whenever their bowels are freely opened. In some cases of sleeplessness I have found that a draught in our Hospital Pharmacopœia succeeded better than an opium draught, and you would hardly imagine *a priori* which draught that was. It was the haustus menthæ sulphuricus cum magnesii sulphate, which contains sulphate of magnesia 60 grains, sulphuric mint draught up to 1 ounce. This given three times a day has produced sleep in cases where the patients suffered from sleeplessness. I do not know whether in them the sleep was due to the removal from the bowels of some substance which tended to prevent sleep, or whether it was due to some alteration in the filling of the abdominal vessels caused by the sulphate of magnesia; but, at any rate, sleep came on. As you are almost certain to get in your practice a great number of cases of sleeplessness, it is worth while to remember that in some of them you may be successful in inducing sleep by keeping the bowels freely open.

Then, in children especially, the temperature is very apt to rise from constipation. There are certain substances, the products of albuminous decomposition, which have the power of raising temperature, and it is quite possible that the rise of temperature in constipated children may be due to the absorption of these substances. At any rate, you will find that frequently in children there is a rise of temperature when the bowels are confined, and the same thing may be observed in many cases of disease in our hospital wards. In cases of pneumonia, especially during the stage of convalescence, and very markedly in cases of typhoid fever during convalescence, the temperature goes up if the bowels become constipated. In these cases, upon clearing the bowels gently out the temperature will fall again to its usual level.

Effect of Purgation upon Arterial Tension.—In the case of old people, and where there is a tendency to high arterial tension generally, purgatives are often required to keep the bowels gently open, and by this means prevent that congestion of the cerebral vessels so often giving rise to a feeling of fulness in the head, which may be possibly associated with threatening apoplexy. Now very likely you will be puzzled at one of the statements in my "Text-book of Pharmacology," which I have copied from Dr. Matthew Hay, viz., that the usual consequence of the administration of sulphate of magnesia to animals is to raise the blood pressure. I have no doubt that the experiments upon which the statement is founded are correct so far as they go, but you must recollect that they were made upon perfectly healthy animals, and the usual result of the administration of a saline purgative to patients is not to raise, but rather to depress the arterial tension. The reason for this is that in many cases where you administer a purgative you are not dealing with a perfectly healthy individual, but with a man under abnormal circumstances, whose pressure is probably raised, and the usual effect of the medicine is to bring it back to the normal. There is another advantage occasionally in using laxatives, and that is that you thereby prevent straining. Straining at stool tends to raise very greatly the intra-abdominal pressure, and thus to put a strain upon the vessels of the brain, and during this there is in elderly people a great risk of the occurrence of apoplexy. In persons suffering from aneurism, straining at stool is especially to be avoided, because it may cause a rupture of the aneurism; and the same thing holds good in patients suffering from phthisis with a tendency to bleeding from the lungs. Wherever there is a tendency to hernia, straining ought to be avoided, because the hernia tends to protrude. During pregnancy one must be careful to avoid straining, because it may induce abortion. It is for this reason that the caution is given to avoid aloes in pregnancy, because this drug tends to irritate the rectum. A small dose of aloes is an exceedingly useful adjunct to other drugs in producing a complete evacuation, but if aloes be given in large quantity, it has a tendency to irritate the rectum, and thus to produce straining. You may get straining and a desire to defæcate from irritation in the mucous membrane of the bowel itself, as well as from something contained in the bowel. In order to prevent straining during pregnancy, one generally gives a mild laxative, such as the confection of senna, confection of sulphur, or compound liquorice powder. The best of all purgatives is, as I have said, castor oil, if the patient can take it, and because of its safety it is generally used by women after delivery, because it has no bad effects.

It is not always necessary to clear out the whole of the intestinal canal by a purgative, because frequently the absence of a motion does not depend upon want of power or want of action in the upper part of the intestinal canal, but upon a torpid condition of the rectum itself. This torpid condition is brought about more especially by habit. You know that poor people in the slums of London, and also in foreign countries, become used to the presence of vermin upon their bodies. Some of the patients who come to the Hospital are in such a condition with vermin that if any of you were in such a state, you would be utterly miserable and could not endure yourselves, and yet they are so accustomed to it that they do not mind. The same thing that happens to the skin happens also to mucous membranes, and while the mucous membrane of a normal rectum cannot stand very well any fæcal matter pressing upon it—because it is sensitive, and reacts readily, and brings about the desire to defæcate—yet this mucous membrane may be gradually trained to bear the pressure of a large quantity of fæcal matter. So by-and-by the rectum becomes accustomed to the presence of irritating matter in it, and the irritation no longer gives rise to a desire to defæcate, and thus the habit is acquired of going on day after day without evacuating the bowels, although there is in the rectum and large intestine generally enough fæcal matter for enormous evacuations. Now, one of the best ways of getting rid of this tendency is, as I have said, to cultivate the habit of going regularly, but sometimes before this habit has become acquired it may be necessary to use some help, and one of the adjuncts which have been introduced of late years, and is getting very much into fashion, is the practice of using a little glycerine, either in the form of an enema, or as a suppository. When the rectum is filled with fæcal matter which does not irritate it, if you simply introduce a glycerine suppository this acts as a most powerful irritant, and the rectum at once responds, the bowels are emptied, and the patient is relieved. In place of the suppository, you may simply inject 1 or 2 fluid drachms of glycerine into the bowel, and the result is the same. An old-fashioned method of treating constipation in children was by a little bit of yellow soap; this was cut into the form of a suppository and introduced into the anus of the child. This was employed a long time before the introduction of glycerine suppositories.

When the bowel is filled higher up with fæcal matter, you may use an enema consisting of a large quantity of fluid, one of the most common liquids employed being simple water or soap and water, or you may employ medicated enemata, an excellent one being that of castor oil. An ounce of oil is mixed either with soap and water, or, better still, with some thin starch mucilage. This is exceedingly good, as the thin starch seems to emulsify the castor oil better than the soap and water, and it is easier to give. This enema is not official, but another excellent purgative enema is contained in the Pharmacopœia, the enema magnesii sulphatis, containing sulphate of magnesia, 1 ounce; olive oil, 1 ounce; mucilage of starch, 15 fluid ounces. The ordinary quantity of fluid for a purgative enema is 16 fluid ounces.

The way to introduce an enema is by means of a syringe. I show you one of the old-fashioned syringes made of metal; they have gone very much out of use now. I also show you a larger one, which may be used as a stomach-pump, and which has a nozzle for the administration of enemata also. Most of these have been displaced by the soft rubber enema syringe. In introducing the enema one should be careful to fill the syringe with fluid, and expel all air from it before injecting. The ordinary nozzle is made of bone or ivory, but I am quite sure I have seen cases of ulceration of the rectum which were produced by the pressure of a hard ivory nozzle. A much better plan is to use a soft rubber tube, which can be simply placed upon the end of the ordinary nozzle, and then introduced into the rectum, with little or no risk of any ulceration being produced. In place of the syringe one may use simply a funnel and long rubber tube attached to a nozzle, and here again the soft rubber nozzle is a most useful adjunct.

Sometimes you may wish to wash out the upper part of the large intestine, and for this purpose it is necessary to introduce a great deal of fluid. If you inject the fluid quickly, you defeat your own object, because you thus distend the rectum and bring about a desire to defæcate, and the whole enema is returned; if you inject the fluid gently into the intestine so as to get it past the sigmoid flexure, you may fill nearly the whole of the large intestine with fluid without almost any desire to defæcate. This is to be done by putting the fluid in under low pressure, and if possible by pushing the tube far enough up to get round the sigmoid flexure. If you can push your tube so far up that it passes well into the sigmoid, you can pour in your fluid, and it runs up the descending colon, across the transverse and into the ascending colon, and still there is almost no tendency to defæcate. In this way you can pour in sometimes about two quarts of water or other fluid without giving rise to defæcation. This method is employed in cases where we wish to use an astringent high up in the intestine, where old ulcerations are suspected, or where it is desired to wash out the contents of the cæcum.

Nutritive Enemata.—There is another condition in which this method is used, and that is when enemata are employed for the purposes of nutrition. If you only introduce a small quantity of soluble nutritive material into the rectum, you cannot expect a great deal to be taken up, but if you can pour into the patients' large intestine a couple of pints or more, say of peptonised milk, you may get the patients' nutrition kept up for weeks together, although they are unable to take anything by the mouth. In cases of severe gastric ulcer, where the stomach is so intolerant that any attempt to feed by the stomach brings on a return of pain, of vomiting, or of bleeding, you may be obliged to keep your patient alive for several weeks together by the introduction of nutritive enemata. I have kept one patient on nutritive enemata for six weeks, with the result that the patient gradually laid on flesh instead of becoming thinner than before. Unless you are careful to introduce the enema under low pressure, and by a tube well up into the bowel, you may be apt to fail. The pressure should be very low; you should not have the funnel raised much more than about 18 inches above the patient's hips, because it is the rapid distension of the bowel that tends to bring about the reflex contraction which is accompanied by defæcation. There is another little point that is sometimes very useful, viz., that the tendency to evacuate the bowels usually comes on immediately after the introduction of an enema, but if it be resisted it passes off in a very short time. The patient may not be able to resist the desire, and then the plan to adopt consists in simply folding a napkin, applying it to the anus, and keeping it pressed there for several minutes after the enema has been given. In this way I have been able to get a nutritive enema retained by a child who previously had returned everything as soon as it was injected.

The rectum forms a vehicle for the application of other therapeutic measures. In some cases a large amount of flatus accumulates in the intestine. I have already described the action of carminatives in removing flatus from the stomach and the upper part of the intestine, but every now and again you will come across patients whose belly is distended like a drum by the accumulation of flatus in the intestines, and in some instances the distension is so great that it threatens life. It drives the diaphragm up, the lungs and heart cannot work, and the patient is in actual danger of death, besides being in great pain. Occasionally one tries to remove this by the simple passage of a tube up into the bowel, so as to allow the flatus to escape through the tube. Besides this, you may inject into the intestine various carminatives, such as dill-water, or a mixture of dill-water and chloroform water, or tincture of cardamoms, but the most efficacious of all is, I think, the injection of asafœtida. We have in the British Pharmacopœia the formula for an enema of asafœtida, which is an exceedingly good carminative. This consists of half a drachm of asafœtida rubbed up with 4 ounces of water. The quantity of water here is very much less than what is used in the case of a purgative, but it is just enough to distend the rectum thoroughly. Very frequently the enema is not made by rubbing up the gum resin of asafœtida with water, but simply by pouring a quantity of the tincture—a drachm or a couple of drachms—into the same quantity of water or of starch mucilage. Then you may wish to apply drugs having a sedative action to the rectum. The most useful of these preparations is the enema opii, but we will consider this presently under the head of diarrhœa.

After-effect of Purgatives.—While discussing the action of purgatives, I may as well mention that frequently after a violent purgative there are three disagreeable consequences which may ensue. One disagreeable consequence is a feeling of great faintness, and we must be very careful about giving violent purgatives to very feeble persons, whether they be feeble from disease or from advanced age, or from extreme youth, because such patients do not bear them well. Where the weakness is very great, it is sometimes advisable just before the bowels are opened to give a dose of brandy, so as to stimulate the heart and prevent the faintness coming on which might otherwise occur. A second disagreeable consequence is that one part of the bowel may be pushed on into another, and it is not only in children that this is likely to take place, but even in adults a certain amount of invagination of the sigmoid into the rectum may occur. In children you are more likely to get invagination of one part of the small intestine into the other as a consequence of a violent purgative, or else prolapsus ani may occur; in adults you are not so likely to find either of these two conditions as you are to have prolapse of the sigmoid into the rectum. This sometimes gives rise to prolonged diarrhœa; so that, after the action of a purgative, a diarrhœa may come on which hardly anything seems to stop. This also we will consider under the head of diarrhœa.

Hæmorrhoids and their Treatment.—A third condition which frequently comes on after a violent purgative is piles. Piles chiefly consist in a dilated and varicose condition of the hæmorrhoidal veins; they give rise either to a good deal of pain or to a good deal of bleeding, and they are sometimes very troublesome to treat. One way of treating them which is very useful is to wash the bowel immediately after each motion, because when the anus is simply cleansed with a piece of paper, as is often the case, small portions of fæcal matter may be left between the piles. In the anus of a healthy individual the end of the bowel may be level with the external surface, but when there are piles, they may protrude and project in lumps and folds; between those folds the fæcal matter settles, and there it acts as a powerful irritant. The piles are thus made worse, and the fæcal matter cannot be removed by simple wiping, but if removed by washing immediately after a motion the occurrence of piles will often be prevented, and if present they will be relieved. When this is not sufficient, a local astringent may be used, and one of the best is hamamelis in various forms. The extract of hamamelis, although only recently introduced into the Pharmacopœia, is by no means a new preparation. The proprietary preparations of hamamelis are very much better than the official. They act exceedingly well, and may be applied to the piles externally by simply bathing them after a motion, or with a little bit of wool steeped in the hamamelis solution, or a little pledget may be made of either cotton wool, or, what is still better, prepared sheep's wool. This is pushed partly within the anus, so that it is caught about its middle by the sphincter ani. The hamamelis is thus applied to the piles inside the rectum by the upper part of the pledget, which is held *in situ* by the sphincter. The part of the pledget outside the anus has a double action, for it exerts a slight pressure on the piles, while it also keeps the hamamelis constantly applied to them. In other cases where the piles are inside the anal orifice, you may apply the pad in the same way, but putting it further in, or you may inject a little hamamelis by means of a glycerine syringe. In cases where the piles are very bad, and where the patient objects to an operation, relief is very often obtained by the application of a sort of support. Frequently men who suffer from piles have a way of sitting on the corner of a table, or upon the arm of a chair, as the pressure against the piles gives them relief from the heavy, dragging feeling which they experience. In place of this, one can get a rectal support which presses up the piles, and comes to the same thing as if one were sitting upon the arm of a chair or corner of a table.

Mechanics of Defæcation.—In the lectures on midwifery a good deal of care is expended upon the description of the method of supporting the perinæum during labour. In the diagram we will take A as the pubic bone, and B as the sacrum. You know that the axis of the pelvis strikes about the lower part of the sacrum, and in order that the child's head may be born it must

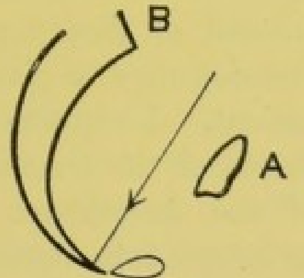

Fig. 128.

be directed forwards. For the purpose of doing this, the perinæum is supported, otherwise the child's head would strike against the perinæum, and would protrude it without getting forward to the vulva. The same thing occurs, though to a less extent, with fæces in the rectum. In the construction of mankind there is a double provision for preventing involuntary evacuation. For example, we have first of all the sigmoid flexure, which acts as a syphon trap, and prevents the fæcal matters coming straight down from the descending colon into the rectum. So long as they are in the sigmoid they do not excite peristaltic action, but whenever they get into the rectum they excite peristaltic action and a tendency to defæcate. In the same way the fæcal matters in the bowel are pressed by the action of the intestines backwards during defæcation in such a direction that they do not tend to strike the anus, but to strike a point a good deal behind it. Usually the floor of the pelvis in most people is sufficiently tense and firm to turn the fæcal mass forward, so that it passes out through the anus, but occasionally, especially in women who have borne a good many children, and whose pelvic floor is very lax, the pelvic floor may need assistance in ordinary defæcation just as it does during parturition. In some patients who find that they cannot readily pass a motion, a little pressure just below the coccyx is sufficient to turn the fæcal mass forward and allow them to get rid of it. More especially is this the case when the fæcal masses are pretty hard, so that they do not pass very readily through the anus. Occasionally the fæcal masses, by a prolonged stay in the rectum, may become so hard that they require the aid of the medical man, who breaks them down with the handle of a spoon or some other instrument, in order to extract them. Sometimes, instead of simply pressing just below the coccyx, the requisite tension may be given to the pelvic floor by the attitude of the patient. I suppose that the only people in the world who use closets of the form adopted in this country are the English and the Americans. In nearly all other countries, the position adopted in defæcation is the crouching attitude, and sometimes persons who are unable to evacuate the bowels when sitting upon a closet of the ordinary form are able to do so by using the crouching attitude, just as is used in Germany, France, and elsewhere. This may be done either by telling the patients to have in the closet a chamber-pot *over* which, not *upon* which, they may sit, and thus evacuate the bowels. This seems a very slight thing to tell you, yet, oddly enough, I think one of the most grateful letters I ever had in my life was from a patient to whom I had given this simple instruction. She had been suffering from constipation for several years, and had been taking purgatives for a very long time for this disorder, but had never obtained relief. She followed my advice, and was able to get on quite comfortably without the use of purgatives.

Diarrhœa.—We may now turn from the action of purgatives to the treatment of diarrhœa.

Diarrhœa is a condition in which we find the actions of the bowels are too loose, and generally at the same time they are too frequent. You can readily understand that diarrhœa may depend (1) upon increased rapidity of movement in the large intestine, whereby the fluid contents of the cæcum are passed onwards to the anus without time being afforded for absorption, or (2) upon increased secretion from the mucous membrane, or (3) upon both diminished absorption and increased secretion acting together. Diarrhœa is frequently brought about by irritating substances. A man eats too much, more than he can digest, and the consequence is that either he is sick and vomits it, or it passes into the intestine and brings on a fit of diarrhœa, which clears the whole of the offending matter away, and he is all right again. Sometimes, however, the whole of the irritating matter is not cleared away so quickly, and it causes irritation of the bowel, which is more or less permanent, and many cases of diarrhœa are best treated by the administration first of all of a purgative. One of the quickest ways of curing diarrhœa, due to some irritating article of diet, is to give a dose of castor oil, say half an ounce, with 7 or 8 minims of tincture of opium in it. The castor oil tends to clear out the whole of the intestinal tube, and the opium leaves a sedative influence behind. But even after the bowel has been cleared out, and the irritating matters removed, there may be irritation remaining in the mucous membrane of the intestine itself. The intestine will go on acting briskly, the mucous membrane secreting, and a watery diarrhœa continues. When this is the case sedatives may be given which will act upon the mucous membrane and muscles of the intestine. Amongst the sedatives which act upon the mucous membrane, and possibly also upon the muscles, perhaps the commonest is chalk. In the mistura cretæ of the British Pharmacopœia you have finely prepared chalk suspended, with the aid of a little mucilage, in some cinnamon water and sweetened with syrup.* Its efficacy is, I think, a good deal increased by the addition to each ounce of it of 10 or 15 grains of carbonate of bismuth, which goes very well with the prepared chalk. We have in the Hospital Pharmacopœia a very good draught which is useful both for irritability of the stomach and of the intestine. It consists of subnitrate of bismuth, 10 grains;† bicarbonate of soda, 10 grains; and chloroform water, up to an ounce. There is one

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* Mistura cretæ :—

Prepared chalk ...	.... 1 part.	
Gum acacia in powder	.... 1 part.	
Syrup....	.... 2 parts.	
Cinnamon water	.... 30 parts.	Dose, ℥i—℥ij.

† Haustus Bismuthi, St. B. H. Pharm. :—

Subnitrate of bismuth	.... 10 grains.
Bicarbonate of soda....	.... 10 grains.

Chloroform water to 1 fluid ounce.

thing to be noted about this prescription, viz., that the subnitrate of bismuth acts as an acid, and if you mix with it a good deal of bicarbonate of soda you will get the carbonic acid set free, and either the cork will be blown out, or the bottle will burst. These draughts in hospital practice are made up beforehand, so that the excess of carbonic acid has passed off, and what the patient gets is carbonate of bismuth and bicarbonate of soda partly reduced to the carbonate of soda. In private practice it is better to prescribe 10 grains of carbonate of bismuth, 10 grains of bicarbonate of soda, 10 minims of spirit of chloroform, and an ounce of cinnamon or peppermint water. Opium is one of the most powerful intestinal sedatives, and in the British Pharmacopœia we have two preparations which are very useful for lessening diarrhœa. We have the ordinary chalk mixture which I have already mentioned, but it is an awkward thing to carry a bottle about, and frequently patients cannot take a bottle with them when they are travelling. Yet it is just when they are moving about that diarrhœa is apt to come on. So we have a very convenient preparation in the pulvis cretæ aromaticus of the British Pharmacopœia. The essential ingredients of this are the same as in the chalk mixture, although there are two or three other substances in it. The most important ingredients are prepared chalk, sugar, and cinnamon; saffron, cloves, and cardamoms being introduced as carminatives, because in cases of diarrhœa you are very apt to get a good deal of flatus present and griping also. These latter drugs tend to lessen the griping and remove the flatus. Yet this powder does not always soothe the intestine sufficiently nor remove the pain and griping, but it will do this if you combine opium with it, so we have in the Pharmacopœia pulvis cretæ aromaticus cum opio. This contains opium in the proportion of one part in 40. In estimating the dose of this powder you do not reckon the amount of chalk, but base your calculation upon the quantity of opium you wish to have. You should give about half a grain of opium for a dose, *i.e.*, 20 grains of this powder; and there is no risk at all in prescribing this.

I should mention in this connection the form of diarrhœa, to which I referred a little while ago, in cases where the sigmoid flexure has been driven down into the rectum. There it causes a sort of protuberance, and acts as a chronic source of irritation. Unless you treat this locally, the diarrhœa will go on; and general remedies, such as those I have been speaking of, are of little use. It should be treated by the local application of astringents, such as a drachm of tincture of catechu in 2 ounces of water injected into the bowel after every motion and retained as long as possible. Another form of diarrhœa is that depending upon malignant disease of the rectum or of the lower part of the large intestine. I daresay that you know that a great deal of discussion has taken place as to whether cancer is increasing or not. There is no doubt that cancer is increasing if you have regard only to the Registrar-General's returns, but I doubt very much if it is really increasing. What is increasing is the power of medical men to detect it, which they owe to more thorough training during their student days, and also the care and attention they give to the examination of their patients. There are many cases of cancer of the rectum which pass undetected and are put down simply as cases of chronic diarrhœa. Whenever you get a case of chronic diarrhœa which resists treatment, it is a good rule always to examine the rectum. It is a disagreeable thing both for the patient and for the operator, but it is a thing in which the feelings of both should be set aside, and an examination made, because without it many cases of serious disease remain long undetected, while if they were found out a little sooner either the cancer might be cut out, or local applications might be given which would ease the patient. I have seen cases of this sort where patients came for, as they thought, quite trivial ailments, but on examination of the rectum cancer was discovered. I do not know that there is anything more disagreeable to a doctor than to have to do what once happened to me. One day an artist came to consult me. He had been working hard all his life, and had just reached the summit of his ambition, becoming recognised as the first artist in his own department in this country, and there seemed to be before him a long life of honour and wealth. He complained of a little diarrhœa, and a little pain and straining. I examined the rectum, and I found what I thought was cancer. I did not like to tell him that he had cancer; for I did not feel absolutely certain. I sent him to Mr. Curling, who was then a great authority on diseases of the rectum, and he came back with a note saying there was no doubt about it. I seem yet to see that man going away from my door with his head bent down, and all joy and hope gone from his face. He lived on for two years, and during this time would get up during the night to work at his engraving because the pain was so great, he could not lie in bed. The diet-table which he could use was very limited indeed. There was one thing that seemed to suit him very well, and that was beef-tea custard. This is made by taking the yolks of three eggs and the whites of two, beating them up separately, and then together. Then mix with this a quarter of a pint of strong beef-tea; pour the whole into egg-cups or glasses, which are placed in hot water until it has set.

LECTURE 23.

Diarrhœa, *continued*—Matutinal diarrhœa—Diet—Effect of lime-water on digestibility of milk—Results of undigested and coagulated milk—Infantile diarrhœa—Bactericidal action of sudden change of diet—Intestinal astringents and sedatives—Astringent and anthelmintic enemata—Worms—Anthelmintics—Santonin—Irritant poisoning—Local and general symptoms—Remote effects—Action of drugs upon the liver.

GENTLEMEN,

Matutinal Diarrhœa.—At the close of last lecture we were discussing the effect of various diets on diarrhœa. Diet is one of the most important points in the treatment of diarrhœa, both in relation to the time when the food is taken and to the quality of the food. There is one form of diarrhœa that you are likely to meet with pretty frequently, and it is sometimes very troublesome. It is known under the name of "morning diarrhœa." The patient wakes perhaps rather early in the morning with a desire to go to the closet. It may or may not be accompanied by pain. There may be two or three motions in the morning before, or immediately after, breakfast, and these may continue at intervals for two or three hours, but after midday the patient is usually quite free from diarrhœa, and is able to walk about without any trouble whatever. Occasionally you may treat this form of diarrhœa successfully without any medicine whatever, by merely giving the patient one simple rule, viz., to take no liquid at all after six o'clock in the evening. You know that if you give a healthy person a dose of medicine at night, it tends to lie in the stomach and intestines and to work as soon as the patient gets up next morning. Now, there are certain people in whom liquid taken in the evening has almost exactly the same effect as a dose of salts taken by a healthy person: the fluid is not absorbed, it remains in the stomach or in the intestines, and is passed out next morning when the patient either awakes or gets up.

Diet in Diarrhœa.—In all forms of diarrhœa it is generally advisable to avoid substances that are irritating either from their physical or from their chemical properties, and I may shortly say that the substances that you desire to avoid in patients who are troubled with diarrhœa are the very things that you recommend to those who are troubled with constipation. So that the rule you give is to avoid all food which will cause either chemical or mechanical irritation. In regard to chemicals you tell them to avoid all substances containing quantities of neutral salts, such as fresh fruit or stewed fruit, or much sugar. In regard to mechanical irritation the rule is a very simple one, viz.,

> "Avoid all skins and bones,
> Strings and stones."

The rule is such a short one, and so easy to recollect, that patients are very likely to remember it and to stick to it. Although it is so short, it is pretty inclusive because it takes in the skins of fish, of flesh, of fowl, of fruit, and of vegetables. Bones include those of animals, of fowls, and of fish; strings include stringy meat of all kinds, sinews, the stringy fibres of vegetables and of fruit, the stones or seeds either in vegetables or fruits. Skins are very frequently eaten indeed. For one thing, the skin of fish is a tasty thing, and patients are very likely to eat it. They do not think about it in the case of fruit, but swallow it down without more ado. In cases where the skin cannot be removed from the fruit, tell them to avoid the fruit altogether. The skin of a grape can be removed, but you cannot remove it easily from a raisin or currant; so that they must be forbidden even though you allow the patient to eat grapes. You must remember, however, that grapes contain a good deal of neutral salts, and it may be necessary to advise patients to leave off grapes altogether. Then the skins of vegetables, tomatoes for example, must be avoided. The skin of certain fish cannot be removed and in that case the patient must avoid the fish altogether. In the case of whitebait, for instance, you have to deal not only with skin, but with bones, and these must, of course, be completely avoided. Bones are dangerous things, not only to persons suffering from diarrhœa, but to healthy persons; and I was a good deal struck some time ago with an accident that happened to one of the porters here. After he had finished his work for the day, he was suddenly doubled up with pain. I sent him up to one of the wards at once. The pain was then in the right iliac fossa; next day it passed off, but it reappeared in the left iliac region; it passed off again, and the third day it reappeared in the rectum. The house physician examined the rectum, and found a fish-bone about 2 or 2½ inches long stuck right across the passage. Apparently it had come from the head of a cod. It was sharp at both ends, and it was impacted right across the rectum. It was lucky that it did not get impacted in a similar manner higher up in the intestines, as then probably a surgical operation would have been necessary. There is another kind of food in which you are very apt to get bones, and so it is well to interdict it to patients suffering from diarrhœa, and that is curry or hashed meat generally. In curry one is very apt to find small spiculæ of bones, which are not detected readily, and it is, therefore, better that this dish should be avoided.

The strings of meat, such as the fibres of beef or tendons of any kind, must be avoided. In cases of diarrhœa, one often wishes patients to take a piece of chicken, and if they eat the breast of the chicken that is all right, but if they take the legs that is all wrong, because they very often get hold of the tendinous parts in the leg, which are very indigestible, and may do mischief. Then the stringy kinds of fish are to be avoided. For example, in cases where the patients' alimentary canal is very irritable, you may allow them with perfect safety to eat small fish, such as whiting and, perhaps, soles, whereas the larger fish, such as cod, may not be satisfactory, because the fibres in the flesh of the cod are much larger, thicker, and harder, and, therefore, cannot be digested, but may pass through the stomach into the intestine, and there cause mechanical irritation. Some fish should be avoided on account of their chemical properties, for instance salmon, mackerel, and herring, because these are very rich fish, containing a quantity of fat, and on that account are apt to disagree. Stones or seeds are very often taken unthinkingly. In strawberries, for example, the little flat seeds or achenes, which botanically are really fruits stuck on the outside of the large receptacle of the strawberry, are absolutely indigestible. One knows that prehistoric man used to eat strawberries, because in the fæcal matters which have been found surrounding the houses of the lake-dwellers strawberry seeds are present. They have probably been there for thousands of years, quite undigested, just as they passed from the intestinal canal, and they are to be found to this day. Perhaps you will remember that these seeds are absolutely indigestible, if you simply think that there is a very good reason for their indigestibility, viz., that if they were digested the seeds would not propagate ; the plants would not grow. It is on account of the indigestibility of the seeds that they pass through the intestines of animals or of birds, and thus travel from one part of the world to another. For example, the ocean birds may pick up the seeds of a plant in one island and convey them, perhaps hundreds of miles, to another and there deposit them.

A very good rule is to allow patients who are suffering from diarrhœa nothing that has not been passed through a fine hair sieve or that has not been so thoroughly well masticated in the mouth that it would pass through a sieve without leaving any residue. In very bad cases you cannot allow the patient the alternative. If the patient is not very ill, and is very careful, you may say that he may take various articles of diet if he will masticate them thoroughly ; but if the diarrhœa is very bad, you must either give such things as would pass through a sieve without any mastication, or such things as have actually been passed through a sieve. In cases, for instance, where we know there are open ulcers in the intestine, food forms the most important part of the treatment of the patient, and there we generally put him entirely on a milk diet. Occasionally a little barley-water or some beef-tea is allowed, but very frequently one gives milk, and nothing but milk. Now, when you are putting a patient on a milk diet, it is well to remember that milk may coagulate and form firm curds in the stomach, which, passing into the intestine, conglomerate and act as a powerful irritant. Milk does not appear to do this so much in cases of fever, probably because the secretion of the gastric juice is to a great extent suspended in fever, and, there being less acid in the stomach, the milk does not fall down in flakes, but passes in a great measure undigested from the stomach into the intestine. This, I think, is very likely the reason why so many patients, who assure you that they cannot possibly take milk when they are in health, can take it perfectly when they are suffering from typhoid fever. You will be again and again assured in your practice by your patient and his friends that when he is well he cannot take milk at all, and they want you to put him on some other food, but if you persevere you will find that in the great majority of these cases, while the fever lasts at least, the patient is able to take the milk with perfect ease and comfort. Now, in order to avoid milk becoming precipitated in the stomach as hard curds, it may be diluted either with barley-water, or, as is more usual, with lime-water or with soda-water. In cases where there is a good deal of diarrhœa, the best thing to dilute it with is lime-water, and the quantity of lime-water to be added to the milk varies a good deal according as you wish to dilute it more or less. If there is much thirst, so that you can get down two or three pints of milk in the 24 hours, apart from the lime-water that is to be added to it, then you may dilute it more freely; but where there is less thirst, you must regulate the amount of dilution according to the quantity of fluid that the patient is able to take. Sometimes when you find that if you add enough lime-water to dilute the milk thoroughly the patient will not get sufficient nourishment, you then have recourse, instead of the lime-water, to the liquor calcis saccharatus of the Pharmacopœia. The addition of sugar to water greatly increases its solvent power for chalk, and so it comes about that the liquor calcis saccharatus is about 14 times stronger than ordinary lime-water. Under these circumstances the milk can be diluted to a less degree, and it will still be rendered sufficiently alkaline not to be thrown down in the stomach in large, heavy curds, but in small flakes.

The treatment by an exclusively milk diet is useful not only in typhoid fever, but in many cases of obstinate diarrhœa. It is likely that a number of you may be going out to India, and at any rate, even if you do not, you are certain to meet with men who have been out there or in Afghanistan, and have come back with chronic diarrhœa. In many of these cases you may give medicine till both you and the patients are sick of the treatment, and nothing will do any good until you put them on a milk diet and treat them precisely as if they were patients suffering from typhoid fever. You give them milk, and nothing but milk. Occasionally you may find that the patients are able to take the milk and go about their daily avocations, but not unfrequently it is better to put them to bed and treat them there with a milk diet, because they are not able to take enough milk to keep up their strength while they are making demands upon it by following their daily work. If you go to any of the continental spas where patients are treated not merely by milk, but by various other methods, you will generally find that when they are ordered milk directions are given for taking it which run thus:—

The patient is not to drink the milk in draughts, but he is to sip it slowly and frequently, and he is to take a biscuit in one hand and a cup of milk in the other, and to eat a little bit of biscuit between every sip of the milk.

In this way the milk is thoroughly broken up in the stomach, does not form curds, and so does not pass down into the intestine and form lumps there. Now the hardness of the lump which milk may form when taken down in a big draught at once is more than you would conceive. A number of years ago, in the casualty department, I was asked by my colleague, Dr. Wickham Legg, to see something that a patient had brought up. It was a cake about 2 inches or more in diameter, and about $\frac{1}{2}$ inch thick, and it had the appearance of the thick, hard felt that is used for making the soles of slippers. I thought I had seen something like this before, and so I asked her if she had drunk a lot of milk at one draught. She told me she had drunk one or two pints all at once, as she was very thirsty, and a good while afterwards she had been sick and brought up this mass. It was so hard and so big that one wondered how it had managed to come up through the œsophagus at all. What occurred here was that the milk had coagulated in the stomach, and then the gastric juice was not able to dissolve this coagulated caseine, and the filaments of caseine had been simply rolled together by the movements of the stomach until the hard, felt-like mass of curd had formed. What happens in the stomach happens also in the intestine, and milk taken in in large draughts may cause a hard mass to form in the intestines, so hard as to be almost like a stone; the evacuation of this is a matter of great difficulty, and it may give rise to great pain and to great disturbance in the large intestine during its passage.

You have in the treatment of chronic diarrhœa sometimes to avoid giving your patients a large quantity of liquid at the same time as they are taking their solids. If they do this, what frequently happens is that the whole mass, liquid and solid, is not absorbed, but simply passes through the intestine, and the patient loses flesh because his food passes out through the intestine without being digested and without being absorbed. As a rule, in cases of diarrhœa you limit the liquid as much as you can, and allow the patient to take the food as dry as possible. But many such patients suffer a good deal from thirst, and therefore you must permit them to have a certain quantity of fluid. It is advisable to give them the fluid apart from the solids, and the best time to take it is, I think, about an hour before meals. The best form is hot water, which should be slowly sipped, and this frequently quenches thirst a great deal better than cold, and certainly a very great deal better than lukewarm water.

Infantile Diarrhœa.—There is a form of diarrhœa that you are sure to come across, and it will trouble you greatly. It is one of the most fatal forms of disease, and that is diarrhœa in children. I mentioned to you before how very necessary it was in cases of diarrhœa in children to attend to the condition of the feeding bottle, and to see that there was no lodgment of acid-producing bacteria, either lactic or butyric, in the bottle or in the feeding tube. But sometimes you may get the infection so far present in the stomach and intestine of the child that the milk taken at every meal becomes infected, and so the diarrhœa goes on and on in spite of all that you can do to check the introduction of bacteria. There are so many bacteria present already in the intestine that the stoppage of a fresh supply does not seem to make much difference to your patient. In cases of this sort what you do is to try to kill the bacteria that are already present in some way or other. One way is to give intestinal disinfectants, such as, for example, calomel in small doses. One-third of a grain of calomel, repeated every three hours or so, is frequently a very useful intestinal disinfectant in these cases, and, perhaps, what is still more used is grey powder, the dose being $\frac{1}{2}$ grain or even up to 3 or 4 grains. Another medicine that is of considerable benefit is compound rhubarb powder. Rhubarb, as you know, not only has a purgative action, tending to clear out any bacteria that are already present, but tends to have a subsequent astringent action, because it contains a peculiar tannic acid known as rheotannic acid.

One of the most useful ways of stopping diarrhœa in children probably is that of altering the diet. Bacteria have the power, if you give them time, to adapt themselves to their surroundings. A number of experiments upon this point were made by Dr. Macfadyen and myself, and we found that various bacteria acquired the power of liquefying gelatine or of digesting starch, even when they were not accustomed to live upon either medium; that others that were accustomed to live upon starch acquired afterwards the power of liquefying gelatine, and lived well upon it; others, again, at first could not digest starch, but afterwards acquired the power. If you do not give them time to do this, but change their food suddenly, then the bacteria starve, and so by changing the food several times you may starve out all the bacteria present in the intestine, and thus allow the child to recover. When, therefore, it is found that milk disagrees, it may be necessary to change the child's food entirely, and give it nothing but barley-water for two or three days. At the end of this time, you may have to change back from the farinaceous to a proteid diet, and give it nothing but raw-meat juice, or white of egg and water, for a day or two more, and then at the end of this time the child may be able to take milk again.

In cases of diarrhœa in children you will not unfrequently find that the stools contain a quantity of caseine undigested, little flakes of undigested milk. Then the practice usually is to give whey instead of milk, or else to digest the milk previously, so that you give the so-called peptonised milk in place of the ordinary milk. Sometimes you may find that the so-called humanised milk is better even than the peptonised. Here, again, I must draw your attention to the fact that if you over-peptonise milk for any patient, you run a risk of bringing on diarrhœa. Whenever the milk is so far peptonised as to be rather bitter, it seems to have a pretty powerful purgative action in place of the astringent action usually exercised by ordinary milk.

Then, after clearing out the irritating substances in the intestine or removing the bacteria that give rise to the irritating substances, there may still be an irritated condition of the intestinal tube remaining. As I have mentioned to you before, in order to soothe this, we may use chalk, bismuth, and opium, and these may be administered either by the mouth or by the rectum, according to the parts that we wish to act upon. If the seat of the diarrhœa is high up in the intestine, we give them by the mouth, but if it is low down in the intestine, then we may administer them by the rectum. Besides these three, we may have to employ various astringents, and those in general use are either of vegetable or of inorganic origin. The vegetable astringents contain tannin in various forms, more especially rhatany, or krameria, kino, catechu, and logwood. These are used in the forms of infusion, decoction, tincture, or extract. Logwood is a very useful astringent, but you will find that mothers object a good deal to it because, being a strong colouring matter, it stains the child's diapers, and these are difficult to wash a good colour. Extract of logwood is not unfrequently given in the form of a pill, but if you are using it, you must remember to be careful that the pills are freshly made, because on one occasion I saw amongst the fæcal matters passed by a patient suffering from diarrhœa some small, round black things. Neither the doctor who was in attendance nor I could understand at first what they were. He discovered afterwards that they were logwood pills which the patient had taken three months before. We could not make out where they had stayed all that time, but we came to the conclusion that they had probably lodged in some fold, most likely about the sigmoid flexure. Sometimes in cases of obstinate dysentery you may have recourse to still stronger astringents, such as nitrate of silver, sulphate of copper, or sulphate of zinc, and these may be used in the form of pills. Nitrate of silver has a sedative action not only upon the intestine, but also upon the stomach, and it is used sometimes in order to check vomiting. As I mentioned before, there is another drug which is also used to check vomiting, and which is likewise useful in diarrhœa, viz., creosote; but creosote and nitrate of silver must not be given together, for the very good reason that they form a mixture which undergoes spontaneous combustion. Nitrate of silver is sometimes more efficacious when used in the form of solution than when used in the form of pill. It is generally given as a pill when it is wanted to check either vomiting or diarrhœa, because the pill is easily taken, whereas the solution is exceedingly disagreeable, leaving a persistent metallic taste in the mouth, but now and again you may find that where the pill does not succeed the solution may do so.

Sometimes in cases of obstinate dysentery or diarrhœa large injections have been used, a quart or more of fluid being passed up into the intestine, so as to reach if possible the whole of the large intestine, and even the cæcum, in cases where ulceration was suspected there. For this purpose you may use sulphate of copper or sulphate of zinc, and occasionally nitrate of silver has been employed also. The disadvantage of the nitrate of silver is that if a large quantity be used, a good deal may undergo absorption, and you may by-and-by get that very disagreeable colouration of the skin which one very rarely sees nowadays, but which a number of years ago was by no means uncommon. Epilepsy was then treated with nitrate of silver, and being a very obstinate disease, the treatment was continued for a length of time until the patient became of a curious livid colour, with a sort of green tinge, such as you may see in an over-exposed photograph before it has been toned and fixed.

In cases where you employ such large enemata you use a very dilute solution. As a matter of fact, only a very small proportion of the substance is absorbed, its action being chiefly local. You should not begin with more than a quarter of a grain or half a grain to the ounce, gradually increasing it as you find the patient able to stand it.

WORMS AND ANTHELMINTICS.—Large enemata are sometimes used also for another purpose, viz., to clear out worms. There are three kinds of worms that are very troublesome, viz., the small threadworms, the large round worms, and tapeworms. The most common of all are the small threadworms, or ascarides. They have their seat generally in the rectum, but they are not confined to the rectum, and they grow and multiply to a great extent also in the cæcum. In the rectum they cause itching and discomfort, and by getting out of it and crawling about outside the anus they often give rise to great disturbance; the child is prevented from sleeping and wastes, without any one being able to see any distinct reason why. Such a child presents a distressing but characteristic aspect, the face gets drawn, becomes pale with dark circles under the eyes, and frequently the child grinds its teeth at night, and has a habit, curiously enough, of picking its nose. These signs very often indicate the presence of worms in children, and the diagnosis is frequently confirmed by the mothers or nurses seeing the worms either in the fæces or on the child's anus. These threadworms are generally treated locally by enemata of salt and water, or of a strong infusion of quassia, or of an infusion of quassia mixed with perchloride of iron. Internally one gives santonin or santonica. Santonin, which is the active principle of santonica, is now generally employed, and as children have difficulty sometimes in taking powders, we have in the Pharmacopœia a lozenge which contains 1 grain of santonin, and ordinarily one gives somewhere about three or five lozenges. Another way of giving the santonin is to make a small sandwich of thin bread and butter and spread the santonin upon it, and then sprinkle on a little sugar. The child takes this pretty easily, as the santonin has not very much taste. It is generally advisable to give santonin at night, because if it is given during the day it disturbs vision so much that everything the individual sees has a curious greenish yellow colour. This is supposed to be due to paralysis of that part of the visual apparatus which performs the function of perceiving purple. If santonin be used in the morning the colour will last a great part of the day, but if it be taken at night the greenish colour will disappear in about half an hour or less after the patient awakes. It is usual to give santonin for two or three nights running, and after the third dose to administer a pretty strong purgative, say a dose of castor oil or a dose of salts and senna, or a mixture that, I think, was introduced into the Pharmacopœia especially for the purpose, but which, is not often prescribed: the mistura scammoniæ. It consists of scammony in powder 6 grains and milk 2 ounces. It is just possible that this may be very efficacious, and it is well to bear it in mind, because sometimes cases of worms are very troublesome, and you may give medicines again and again until you are tired.

In adults you may find that these threadworms are also very troublesome, and that, although you wash out the rectum time and again with these injections, the worms still continue to trouble the patient. Under these circumstances it may be advisable to introduce a large quantity of infusion of quassia into the bowel, so as to wash out the whole of it, including the cæcum, regularly.

In cases of round worms one generally trusts to santonin. Now it used to be supposed that santonin was a vermicide, that is to say that it killed the worms, but apparently it does not. It does not kill the round worms, because when they are put into a solution of santonin outside the body they remain active for a length of time. It would appear, however, that santonin to some extent makes them drunk, so that they are no longer able to maintain their equilibrium in the intestine, and so they are swept out by the peristaltic movements of the bowel itself or by the purgative medicine which has been introduced. After santonin has been taken a good purgative must be given, so as to sweep the bowels well out.

The other worms which trouble patients are various kinds of tapeworms. A variety of drugs are used for these, the most efficient probably being the oil of male fern. This is the one upon which we pin our faith, and the mode of giving it is first of all to clear the intestine out, so that the oil of male fern may have a fair chance of getting at the worm. This is often done by giving a purgative in the morning. During the day the patient should have but little food excepting milk; in the evening as he goes to bed give him half a drachm or a drachm of the liquid extract of male fern either alone, or, better still, with chloroform water. Then he may lie down at once, because the drug is liable to make him sick. Next morning administer an active purgative such as salts and senna or 1 to 2 ounces of castor oil. A curious accident whereby a patient died, and a doctor was tried for manslaughter, on account of a printer's error, once occurred in connection with this drug. In a certain book the dose of liquid extract of male fern was given not as ʒj, but as ℥j, the sign for an ounce being put in place of the sign for a drachm. The doctor gave his patient an ounce of extract of male fern; the patient was exceedingly ill, and came back to the doctor saying: "It has made me very ill indeed." The doctor said: "Oh, it is all right; you must take some more." A second dose was administered, with the result that the patient died.

There are various other drugs that are employed to destroy tapeworms, such as kamala, kousso, and pomegranate. All of these are used, but the one that most often succeeds where oil of male fern fails is turpentine. It is an abominable mixture, but half an ounce of oil of turpentine with the same quantity of castor oil sometimes succeeds in getting rid of a tapeworm that has been harboured for a long time. Here I may perhaps remind you that turpentine is peculiar in regard to doses; that half an ounce or even an ounce of oil of turpentine along with castor oil is not dangerous, but that 1 drachm may be very dangerous indeed. On the other hand, 10 or 15 minims is again a safe dose. The reason of this is that with a dose of 10 minims the oil of turpentine is absorbed and passes out through the kidneys, but it is in too small a quantity to do much damage; a drachm dose will very likely be absorbed, pass out through the kidneys, and be strong enough to damage them very materially; but half an ounce acts as such a powerful stimulus to the intestine that it produces violent purgation, and is carried out through the intestine without being absorbed, and so does not touch the kidneys. The portion absorbed is so small as to do no harm whatever.

Irritant Poisons.—I ought, perhaps, to mention here the effects of irritant poisons, because most of the drugs I have mentioned under the head of drastic cathartics, as well as a number of others, belong to the class of irritant poisons. For example, all caustic alkalies or strong acids and all the irritant vegetable poisons, such as colocynth, etc., may produce violent purgation. Besides these, we have such drugs as arsenic, which is a powerful gastro-intestinal irritant, and is one that is very commonly employed as a poison. In the case of alkalies, such as caustic potash, caustic soda, or caustic ammonia, a burning taste in the mouth is experienced, which often warns the patient that he is taking it by mistake. The same occurs, as I have before mentioned, with croton oil. With regard to the remedies for these cases of irritant poisoning, they naturally differ. In the instance I mentioned of poisoning by croton oil all that was necessary was to give some gruel and get it vomited again. When caustic soda, caustic potash, or caustic ammonia have been taken, the tissues of the mouth and of the œsophagus may be burnt, and the remedy that you would then employ is milk. Milk tends to soothe the mouth and the œsophagus, and forms an albuminate of potash or soda with the caustic alkalies. After it has been swallowed it may also be advisable to give some dilute acid, for example vinegar, which is always at hand, but if the local irritation produced is great the vinegar will make the mouth smart a good deal. Perhaps there is really nothing better than milk, and failing that the white of an egg or even the whole egg beaten up with a little water. In the case of acids milk and egg are also satisfactory antidotes, because they have a sedative action upon the mouth, the œsophagus, and the stomach, and further they have the enormous advantage of being readily procurable. You may sometimes be able to distinguish the particular acid that has been employed by the nature of the stain that it leaves upon the lips. Carbolic acid, sulphuric acid, and hydrochloric acid leave a white stain. In cases where sulphuric acid has had time to act there may be a little blackening, but as a rule it is white. Nitric acid usually leaves a yellowish stain. Ammonia and nitric acid both have such an irritating vapour that they may not only give rise to erosion and inflammation of the stomach and œsophagus, but their action on the larynx may cause spasm of the glottis.

After the acid or alkali has reached the stomach pain usually occurs in the epigastrium and afterwards in the bowels. This pain is increased by pressure, and this is one of the diagnostic points between inflammation of the gastro-intestinal tract and simple spasm. In cases of ordinary colic pain is usually relieved by pressure, but in cases of inflammation of the stomach or intestines the abdomen is so tender that the patient cannot bear any pressure at all upon it. When irritant poisons have been taken reflex vomiting readily occurs. This explains why there is very often no diarrhœa, although these substances are purgatives, the irritant being rejected from the stomach and thus never reaching the intestine. In addition to the local symptoms, however, general symptoms occur, and these are for the most part connected with the circulation. There is reflex depression of the circulation. Usually the patient is pale, and feels very feeble. The pulse is often slow; sometimes it may be rapid, but it is almost always weak. The respiration may be either slow and sighing, or very quick and shallow. You can understand why it should be quick, short, and shallow. The patient is afraid to take a deep breath on account of the pain that the descent of the diaphragm produces, but if the pain be not very acute, then respiration may be deep and sighing. After this stage has passed off, you may get a reaction ensuing such as occurs in inflammation of any organ whatever, the coldness of the skin passes away, the face becomes red, and the pulse becomes full, sometimes hard, and generally rapid. Occasionally inflammation comes on, with high fever. The patient may die from the immediate effects of the poison, or may afterwards recover and suffer from constant dyspepsia, due either to destruction of the mucous membrane of the stomach over a large area or to contraction of the pylorus from cicatrisation of the ulcers caused by the irritant. We may even have death supervening as a consequence. The œsophagus may have been so much eroded by the passage of the irritant that the contraction of the consequent cicatrices closes the œsophagus entirely, thus rendering it quite impervious to food. In such cases all that you can do is to have an opening made in the stomach and let the patient be fed through that. In other instances death may result from inanition, because the whole of the mucous membrane of the stomach has been destroyed, and consequently the food can neither be digested nor absorbed.

ACTION OF DRUGS ON THE LIVER.—We may now pass from the action of drugs upon the stomach and intestines to their action upon the glands connected with the intestinal canal, and first of all to their action upon the liver. You know that the liver was at one time looked upon as an organ that had very little functional activity at all—a useless organ, in fact. So long as it was supposed that the liver had nothing to do but secrete bile, this was a natural conclusion ; but we now know that the bile is only a kind of bye-product, useful, no doubt, but its formation is quite unimportant in comparison with the other functions of the liver. A certain idea of the functional activity of the liver may be formed from the amount of bile it produces, but this bears the same relationship to its activity that the dust-heap outside a factory bears to the amount of work done inside. Bile is almost entirely the residual matter that is passed out by the liver, is really an excretion of the liver. But in many factories they do not throw away all the contents of their dust-heap: they sift their cinders ; they throw away the ash, but the cinders are retained and utilised. In the animal economy we find the same principle of utilisation of waste. The bile formed by the liver is not all passed out in the fæces ; a good deal of it remains, is re-absorbed and made to do duty again and again ; and the rapidity of absorption is very great indeed. Bile injected into the duodenum may be absorbed and passed into the liver and excreted again into the duodenum in half a minute. This statement was made by a man named Laffter* a good many years ago, and I disbelieved it, but I repeated the experiment and found that it was correct. The way this can be demonstrated is as follows: you put with the bile some substance that you can readily recognise, such as, for example, a little rhubarb. When I injected the rhubarb and bile mixed together into the duodenum of a guineapig, I was able to find the rhubarb in the bile that was excreted within a minute. Schiff found that the bile collected from the gall-duct in a dog is yellow, but if green bile from an ox be injected into the dog's duodenum, within a very short time afterwards the bile secreted by the dog's liver is tinged with green. This experiment shows that the liver has two functions: (1) it forms new bile, but (2) it has also the power of excreting bile that has already been formed and has been absorbed. If the whole of the bile be cleared out of an animal's body the liver will produce new bile. But, as the simple experiment with rhubarb shows, the liver does not only excrete the bile that it takes up from the intestine: it has the power of excreting other things. It caught the rhubarb on its passage from the intestine into the general circulation and sent it down again into the intestine. It does this with a number of substances. One often hears the comparison "as bitter as gall," but gall is not bitter if it be fresh; it is only bitter when it is old and when it contains substances to which it owes its bitterness.

* Laffter, "Inaug. Diss." (Breslau, 1873).

LECTURE 25.

Suppositories in diarrhœa—Ointment introducer—Action of drugs on the liver, *continued*—Bilious headaches—Treatment—Cholagogues—Cholagogue purgatives—Salicylate of soda—Action of mercury on the liver—Aloes—Colocynth—Rhubarb—Action of salines—Nitrohydrochloric acid—Toluylendiamine—Gallstones—Carlsbad—Mode of life—Insufficient ingestion of diluents predisposes to gallstones—Salutary effect of hot-water drinking—Diabetes—Treatment—Rôle of the pancreas in diabetes—Action of drugs on the pancreas—Pancreatic tabloids—Milk diet.

Gentlemen,

I omitted at our last meeting to mention one method of treating diarrhœa. I show you some suppositories that are contained in the Pharmacopœia, and which form a useful means of checking diarrhœa; some contain astringents, others sedatives. The most useful of all, perhaps, is the morphine suppository, containing hydrochlorate of morphia, half a grain, made up with cacao butter. This, when placed in the rectum, tends to act as a sedative to the bowel, especially in cases where the diarrhœa depends upon local irritation in the rectum, and is much more efficacious than the same quantity of morphine would be if taken by the mouth. You must, however, always remember that when you are giving morphine by the rectum the dose is usually just double that which you give by the mouth; that in place of giving half a grain of morphine, as you do by the rectum, you would only give a quarter of a grain by the mouth. Notwithstanding that the general action of morphine upon the system is greater when given by the mouth than by the rectum, I think that even the same dose applied by the rectum is often more satisfactory in cases of diarrhœa than when given by the mouth. We have another suppository of morphine with soap, but I do not know that this has any advantage over the preceding one; both are employed for the same purpose. In suppositoria plumbi co. we have sedative and astringent elements combined; this consists of acetate of lead and opium made up with cacao butter. Each suppository contains 1 grain of opium and 3 grains of acetate of lead. The advantage of it is that we have the sedative action of the opium and the astringent action of the acetate of lead, which latter tends to reduce any congestion and swelling that may be present in the mucous membrane of the rectum, and at the same time, if there be any ulceration present in the rectum, the acetate of lead helps to form, as I mentioned before, a pellicle over the surface, and thus assists the ulcer to heal. We have also suppositories of tannic acid, and tannic acid with soap, also with carbolic acid, but the tannic acid is not so useful in cases of diarrhœa; it is used more for internal piles than for its action in diarrhœa, although it may exert a useful astringent action in this affection also.

Where there is irritation of the bowel higher up, at the junction of the sigmoid flexure and of the rectum, the lesion is only reached by a suppository if you tell the patient to lie in a particular way, viz., on the back, with the hips raised. In this position, when the suppository melts it flows upwards to the upper part of the rectum. You may, however, introduce an ointment high up into the rectum by means of an ointment introducer. This is a sort of syringe made of wood; into it you can introduce any ointment you like, only it must not be too hard; in fact, it should be made rather soft. To the ointment bismuth, or lead, or opium may be added, or, any ingredient you please. Having placed the ointment in the introducer, you adjust the piston, and then insert the nozzle of the instrument well into the rectum, and by working the piston a quantity of ointment may be applied to the rectal wall. If you wish to apply it still higher up the rectum, you can put over the end of the nozzle a soft indiarubber tube, and then push the tube well up. The ointment will in this way travel up the tube to the end of the rectum, and it may thus be applied directly as high as the sigmoid flexure. You may even with care introduce the ointment by means of this apparatus well into the sigmoid flexure in cases where you suppose that an ulceration is present. The soft rubber tube passes pretty readily as far as the sigmoid. It is rather a difficult thing to know how far you are able to pass it up. I have passed it so far up in a patient that I have felt it directly under the ribs on the left side, and I was disposed to think from this that I had got the tube through the flexure and up into the ascending colon, because I could feel it in the left hypochondrium, at the place where the colon is normally present. Talking it over with one of my colleagues, he said, "This is not the case; you no doubt felt the end of the tube there, but the reason is that the tube pushed the sigmoid before it." At any rate I have seen very good results from the application of sedative ointment by means of the large tube. The tubes I generally employ are from a quarter of an inch to half an inch in diameter, and if they are well greased they generally pass up without causing any pain whatever, unless there happens to be some ulcer present, when, of course, you require to be careful, as in passing over the surface of the ulcer pain may arise.

Action of Drugs on the Liver (*continued*).—At the end of the last lecture I was telling you that the liver has a double function: that of forming bile and that of excreting bile; and that the bile which is usually vomited has a bitter taste, but bile which is freshly formed has no bitter taste whatever. This we know from cases where fresh bile has been vomited up, and also from cases where there has been a biliary fistula, so that the bile flowed from the liver as quickly as it was formed. In such cases the bile has usually a golden yellow colour, and has been quite free from any bitter taste. The bitter taste is in all probability due to some bitter compound produced during the process of digestion, which is absorbed by the liver, and is again re-excreted in the bile. This bitter compound being formed continually, though slowly, in the stomach or intestine, and being continually re-excreted by the bile, you get at last an accumulation of the bitter substance, whatever it may be, which gives rise to the intensely bitter taste which is usually attributed to bile or gall. We know that if we peptonise milk too long, we get a bitter substance formed, and in all probability something of this sort gives its bitterness to bile. One does not know whether it is the accumulation of these bitter substances in bile that gives rise to some extent to so-called bilious headaches. The constant recurrence of such headaches at periodical intervals seems to indicate that there is a constant formation of something which goes on either until it is excreted, or until its formation is stopped.

Bilious Headaches.—Now in cases of bilious headaches, as probably many of you know from sad experience, a person feels perfectly well for ten days, a fortnight, or a month, and then very likely a headache comes on, during which there is absolute loss of appetite, and which terminates in violent vomiting, during which a great deal of bile is evacuated, and with it a quantity of the bitter substance contained therein. For some little time afterwards the person who has had the headache is immune, one may say, and he may do for the time many things that at a later period he could not do without the certainty of bringing on the headache. For example, a man who has had a sick headache of this sort may, for several days afterwards, drink wine or beer, sit up late at night, go to a theatre, or strain his eyes at a picture-gallery, without bringing on a headache, although later on, when there has been time, as one may imagine, for the bitter substances to accumulate, he would certainly bring on a headache by doing any of these things.

Now in all cases of sick headache there seem to be two factors: a general condition of the body and a local cause determining the pain to the head rather than to any other part of the body. One of the most common of the local factors is disturbance of the eyesight. I should say in 19 cases out of every 20, perhaps I ought to say in 49 out of 50, the exciting cause of so-called bilious headaches is irregular vision, due either to inequality of the two eyes, or to astigmatism. So that although the liver probably has a considerable part to play in the production of headaches, yet, if you can remove the determining factor, you may get rid of the headaches. In all cases where there is general disturbance of nutrition, the point that is apt to suffer is the weakest point, or the point that is most exercised. In persons who lead sedentary lives, and who use their eyes a great deal in reading, the eyes are very apt to suffer, and the patients consequently get headache. Gouty men in the upper classes find that the general gouty tendency is apt to settle locally in the great toe. I daresay you can readily see why ; the joint of the great toe is probably the joint in the whole body that is subjected to the greatest amount of work, because at every step you take this joint is put into action, and you are constantly standing upon it, so that it is almost never free from pressure or exercise. Many men use the joint of one toe more than another, so that you may get gout inclining to one foot or the other according to the amount of exercise given to each. But in a number of the patients coming to hospital we do not find that it is the toe which suffers, but the hands, fingers, or wrist, because many of these patients are during a great part of the day engaged in avocations in which the joints of the fingers and wrist are constantly employed. For example, I saw the wrists become very much affected in the case of a man engaged in polishing furniture. In other cases you may find that the shoulder-joint becomes more affected, but this is not a common thing, because the shoulder-joint is not very much used. I have, however, seen the shoulder-joint affected in a painter whose work was not exactly that of painting, but of distempering and whitewashing, and the shoulder-joint was the one he used most, because he had to swing his arm with the big brush in distempering the walls.

Now, in curing sick headaches, nature seems to get rid of the accumulation of bile, or of substances contained in the bile, in two ways. (1) It causes sickness and vomiting, and thus a quantity of old bile is eliminated, and at the same time (2) the patient is made to starve; he is very often unable to take food for 24 hours, and if he does take it the whole of it is brought up without being absorbed. Physicians long ago used to imitate nature by giving an emetic, and I have very little doubt that in many cases it did a great deal of good; but emetics, like bleeding, were overdone, and so they have fallen very much into disuse. Curiously enough, one patient of mine told me that when she had sick headache if she retched, even without vomiting, she did herself a great deal of good. You can readily see how this would come about. In the efforts of retching, the liver and gall-bladder were pressed between the diaphragm and the abdominal walls, and the bile was squeezed out of the liver and also to a great extent out of the gall-bladder. In most patients it would have been evacuated through the mouth by vomiting, but in this case it seemed to be evacuated into the duodenum and then passed away in the motions. Now-a-days the plan adopted by nature in this case is the one which we generally follow in the treatment of so-called biliousness, and in place of giving an emetic we, as a rule, administer a purgative. But all purgatives have not got the same action. There are some which do not seem to relieve biliousness; they give copious motions, and yet patients feel the same dulness, heaviness, and discomfort that they did before. Other purgatives, again, seem to clear bile away, and the patient after their administration feels bright, lively, and well. The difference between the effect of these purgatives seems to be this: that they do not all affect the same part of the intestinal canal. Aloes, for example, tends to act more especially upon the rectum; and sulphate of magnesia tends to wash out the whole bowel. Neither the aloes nor sulphate of magnesia, however, seems to have the power of relieving biliousness, and one of the most common ways of relieving it is by the administration of one or two drugs that are supposed to act upon the liver itself by clearing out the bile.

Cholagogues and Hepatic Stimulants.—Drugs may affect the liver either directly or indirectly. For example, some may stimulate the liver to increased action, so that it will pour bile more quickly out into the duodenum. The drugs that stimulate the liver to increased formation of bile are termed "cholagogues," or "hepatic stimulants." Perhaps one ought to say rather hepatic stimulants, because the term cholagogue is often employed to designate those drugs that clear the bile not merely out of the liver, but out of the body. More properly we might term those cholagogue purgatives, but this is rather an awkward term, and very often it is shortened down to cholagogues. There are some drugs that stimulate the liver to increased secretion, causing the formation of more bile without stimulating the intestine at all. One of the most marked of these is salicylate of soda, which, perhaps, has a greater action upon the liver than almost any other drug with which we are acquainted. It tends to make the liver secrete a more watery bile, and to secrete it under higher pressure than the normal liver does, so this is perhaps the hepatic stimulant *par excellence*. Other drugs have an action not merely upon the liver itself, but upon the intestine as well, and these tend to act more especially as cholagogues. But you can readily see that if the bile has been secreted it will pass down into the duodenum, the jejunum, and the ileum, and be absorbed again, unless something be given to stimulate the action of the bowel. If you take a drug like salicylate of soda, which acts only upon the liver, you will have the liver secreting more bile, but the bile thus secreted will undergo absorption. If you use a mixture of perchloride of mercury and calomel, you will probably get a double action, viz., increased secretion from the liver, due to the perchloride, and increased action of the duodenum, due to the calomel, which will tend to hurry the bile onwards and prevent re-absorption, but still a quantity of the bile may undergo re-absorption in the lower part of the intestinal canal. So that if you wish to get the maximum elimination of bile, probably one of the best means that can be employed is to give a small quantity of perchloride of mercury to stimulate the liver, some calomel to act upon the duodenum, and then in addition a dose of some saline, which will sweep out the intestinal contents. When this is done the patient generally feels a great sense of relief, and all the disagreeable symptoms which are put down under the head of biliousness are relieved.

Action of Mercury on the Liver.—A great question has arisen as to the real action of mercury upon the liver. It has been long looked upon as a cholagogue, and all the various forms of it are supposed to have a cholagogue action. One of the reasons for this is that mercurials, especially when followed by salines a few hours afterwards, tend to relieve all the symptoms of biliousness. They not only relieve the disagreeable symptoms felt by the patient himself, but when the eyes show a little icteric tinge this disappears also after the administration of a mercurial purgative. Some years ago the question was subjected to an experimental research. The way in which this was done was this: a ligature was placed upon the bile-duct of a dog, so that the bile from the liver, instead of passing into the duodenum, went into the gall-bladder. Into this a cannula was inserted, so that the whole of the bile which was secreted by the liver was obliged to flow outside into a receptacle. After the administration of various drugs, it was found that several of them had the power of increasing the quantity of bile formed in a given time. One of the most powerful is, as I have said, salicylate of soda, and this drug differs from some of the others in this respect: that it has been tested, not only in animals, but in man. It has been tested in a case where a permanent fistula had formed in a patient, and it has been found to have the power of increasing the secretion of bile. Amongst other drugs that increase the flow of bile in man are perchloride of mercury, and several other vegetable products increase it also. Aloes, which, I told you before, acted specially upon the rectum, appears also to act upon the liver. Aloes and colocynth are the two most important ingredients in the compound colocynth pill, which is a very favourite purgative pill, and you can now readily see why it should be, because it tends to clear away a quantity of the residual bile as well as to clear out the fæcal contents of the intestine.

Rhubarb is also a useful hepatic stimulant, although not so powerful as colocynth, and here, again, in ordinary practice we find that patients are very fond of taking the compound rhubarb pill, containing rhubarb and aloes. But this does not suffice for all patients, and a number of them will take, in addition, either a mercurial pill once or twice a week, or one of the newer substances that have been introduced as substitutes for mercury. Amongst those, perhaps, the most commonly employed is podophyllin, and since Rutherford's researches on cholagogues were made, euonomyn and iridin have come to take a permanent place along with podophyllin, because they also stimulate the liver, and do not cause so much griping as podophyllin. We find colchicum and ipecacuanha also amongst the drugs which cause increased secretion from the liver. The latter has long formed a favourite ingredient of dinner pills, and colchicum, as you know, is one of the drugs most commonly employed in cases of gout.

We have, in addition to these vegetable cholagogues, various salines, especially the phosphate of soda and the sulphate of soda. Both of these tend to cause increased action of the liver, but a number of salines have besides the power of increasing the peristaltic action of the intestine. You can readily see that if you sweep away all the bile that is formed, and that is poured into the intestine, you will get a smaller quantity poured out from the gall-bladder, and more especially will this be the case if, by the action of your purgative, you sweep away not only any bile that may be present in the intestine, but you sweep away substances from which bile may be formed, viz., all the half-digested food, which would tend to yield biliary products. There is one other drug that I should mention as being a useful hepatic stimulant, because it is so very much used in cases of so-called biliousness, and that is nitrohydrochloric acid. We have a draught in the Hospital Pharmacopœia which is very much used indeed, and contains 10 minims of nitrohydrochloric acid along with 10 minims of spirit of chloroform, 20 minims of tincture of oranges, and an ounce of water. This is a first-rate hepatic stimulant, and seems also to act as what may be termed a powerful "pick-me-up," especially when combined with about 10 minims of tincture of nux vomica. This gets rid of a great many of the discomforts which are caused by dyspepsia, and which one frequently puts down to so-called inaction of the liver.

Toluylendiamine.—There are some other drugs that tend to cause a tremendously increased secretion of bile, and I may mention particularly toluylendiamine, but instead of making the bile more watery, as the salicylate of soda does, this drug toluylendiamine causes an increased secretion of solids in proportion to the water, so that the bile becomes exceedingly thick, and will not flow through the ducts, and therefore gives rise to jaundice, although the ducts may be quite patent, and although there may be no distinct obstruction. In some cases I have used toluylendiamine as a hepatic stimulant in place of salicylate of soda, and I thought I obtained some good results from it, although the accurate study of the action of drugs in patients is very difficult, because there are so many fallacies. You can thus readily see that retching may possibly be beneficial in cases of jaundice by simply squeezing the liver and driving the bile, mixed with mucus, out through the hepatic duct into the intestine.

Mechanical Removal of Bile.—Sometimes you may actually press the bile out from the liver or gall-bladder by mechanical manipulation. I have, on one occasion at least, succeeded in doing this by gentle pressure on the gall-bladder. This, however, must be done very gently, otherwise you run a risk of doing mischief. In cases where the obstruction does not consist simply of a little mucus or thickened bile, as in ordinary catarrhal jaundice, but is due to a stone which is impacted in the gall-duct, you may do a considerable amount of mischief, and I do not think it is a very safe procedure.

Gallstones.—In cases of gallstone, one generally tries to lessen the irritability of the duct and cause it to relax by the administration of sedatives, such as the compound spirit of ether or so-called Hoffman's anodyne, morphia or opium in various forms, and belladonna. All these tend to relax any spasm of the gall-duct, and thus to allow the bile to flow more freely through, and any calculus that may be present to pass. Salicylate of soda may be beneficial by increasing, to a certain extent, the pressure of the bile behind. The administration of this combined with a mercurial purgative is very serviceable, for by its means one can keep the liver well cleared out, and thus relieve any tendency to jaundice. If you want your patient to receive the maximum benefit, you must pay attention to the way in which the purgative is administered. Sulphate of soda, as I have mentioned, has a certain stimulant action upon the liver, but this is greatly increased if, instead of being drunk down in one large draught, it is taken in repeated sips, and for this purpose one generally sends patients suffering from gallstones to Carlsbad. The reason for the selection of Carlsbad is that people will do there what they will not do at home, and another reason is that they are not allowed to do there as they like. Their mode of life and what they eat are completely regulated by the doctors. In many health resorts patients who do not like to obey orders might disobey them if they please, but in Carlsbad they cannot do so. At Carlsbad the patients' mode of life is pretty much as follows: they get up about six o'clock in the morning, and they go out without any food to the Sprudel, which is the large well where the hot saline springs bubble up, and here they fill their glasses, and walk round and round the promenade for nearly an hour, and at every two or three steps they take a sip of hot Carlsbad water. In this way they get through three or four tumblers in the course of the promenade; then they go to the confectioner's and have a small cup of coffee, and on the way there they buy a small roll or two, and this they eat without butter along with their coffee. Then they will rest for awhile, and after midday, perhaps, go for another walk, and probably take some more water, after which they will have an evening meal, and then go to bed. The food eaten at meals is also regulated. One day I went into a restaurant in Carlsbad, and looking through the bill of fare, I said: "I would like this." The waiter said: "Are you under treatment, sir? The doctors here do not usually allow it, and if you are under treatment you cannot have it without special leave from your doctor." In most other places you simply have what you like, but in Carlsbad you cannot have it. Patients go there for the purpose of getting well, and so they willingly go back to Carlsbad, because they feel the benefit of it, although they would be unwilling to be kept so strictly at home. It is almost impossible to treat them in the same way as at Carlsbad, so we send our patients there.

Operation.—In cases of jaundice, where the condition causing the jaundice is beyond the reach of drugs you have recourse to operation. Operations are now frequently performed for the removal of biliary calculi, and very often this is the only way in which you can cure your patient. I believe that one of the chief reasons why calculi form in the liver is simply that the liver does not get sufficient water to make the bile watery enough; the bile becomes too solid, and then concretions form. If a patient comes to you complaining of symptoms of gallstone, and you ask him how much water he takes, the probability is that he will say, "I hardly ever touch water; I am not a thirsty person." Again and again you get the same answer, until you begin to conclude that the absence of thirst is a cause of gallstones; and, in order to prevent gallstones forming again, one of the best things you can do is to tell your patients to take water regularly. Now a lot of cold water taken at a draught is very apt to lie heavily upon the stomach, and patients do not like it; but if they sip hot water it has not this effect. The best time for patients to take the water is when they rise in the morning or when they go to bed at night, if they cannot be induced to take it at other times during the day as well. A very good time to take it is about an hour before meals, the advantage being that instead of the water diluting the gastric juice, as it would do if taken either with or immediately after a meal, it is absorbed into the system before the meal is taken, and then it is secreted again in the form of gastric, pancreatic, or intestinal juice, or possibly bile. At the same time, water taken before meals tends to wash out of the stomach the residue of the former meal, and thus the patient starts with a clean stomach. Little or no fluid with meals is frequently a most useful prescription in cases of dyspepsia, but plenty of hot water tends not only to prevent the formation of gallstones, but to lessen rheumatism and gout. By giving the hot water on an empty stomach you do good to the liver without damaging the stomach. By the simple prescription of hot water you may sometimes be able to keep your patients for years together free from gallstones.

If the bowels are at all constipated, it may be advisable to let the patient take half a teaspoonful or a teaspoonful of Carlsbad salts or some other salts in hot water in the morning just after rising.

Diabetes.—But, as I said before, the formation of bile is but a small part of the function of the liver. It has another most important function—viz., to act as a coal bunker to the body, to store up the carbohydrates during digestion, and to give them out slowly into the circulation during the intervals. In some cases, the liver does not seem to have the power of carrying on its normal function of converting soluble sugars into insoluble or sparingly soluble glycogen, and then allowing the glycogen slowly to dissolve out or be converted into sugar, and pass into the body. Thus you occasionally find that the carbohydrates which are absorbed from the intestine, instead of being stored up in the liver, pass right through it into the general circulation, and thus are carried to the kidneys and excreted. We then get glycosuria, or diabetes. This disorder may be treated to a great extent by proper feeding. If you cut off all sugars and all foods that will yield sugar, you can generally stop the excretion of sugar in the urine, or at least you can greatly reduce it. The rules, therefore, in a case of glycosuria are:—Cut off all sugars; cut off all starches, because those will be digested, and yield sugars; cut off all articles of diet that will yield either sugar or starch. You will thus cut off all bread, all farinaceous food, all roots which contain starch, such as potatoes; and in the acute form even carrots and turnips, parsnips and artichokes, are debarred. The ordinary rule is that the patient may take fish, flesh, fowl, or eggs, may, in fact, eat anything that comes from the animal kingdom with the exception of the liver, which either in fish, flesh, fowl, or shell-fish is to be avoided. He may take also all green vegetables, but vegetables that are white, such as cauliflowers, parsnips, and potatoes, are to be avoided. There is a considerable dispute as to the advisability of giving milk. In many cases I think it is not only advisable, but necessary. The reason for cutting it off is because milk contains a certain amount of lactose; but I do not think that lactose is upon the same level as glucose or maltose. Lactose may be allowed in certain cases when the other forms of sugar would be very inadvisable indeed.

Now there are one or two drugs that seem to have a great influence upon the liver in tending to lessen glycosuria. Whether it is that the drugs tend to enable the liver to convert the sugars into the form of glycogen or not I cannot say, but the drug upon which we place most reliance in such cases is opium, or one of its derivatives, morphine or codeine. The latter is, perhaps, more frequently employed, because it does not tend to make the patient so sleepy, nor does it tend to constipate the bowels so much as opium or morphine. At the same time, opium and morphine sometimes succeed when codeine fails. Another drug that is very useful is bicarbonate of soda; and in cases of glycosuria we often send patients to Carlsbad, where they get the carbonate of soda along with the sulphate of soda, or to Vichy, where they get the carbonate of soda without the sulphate. It would thus appear that carbonate of soda plays an important part in the treatment of diabetes, because the two springs to which we send our patients both contain carbonate, but do not both contain sulphate. Carbonate of soda given at home is very useful. Innumerable other drugs have been used for the purpose of treating diabetes. The salts of uranium have recently been employed by Dr. West, and in his hands they seem to have had good results; but they do not apparently act equally in all cases, nor should we expect that they would. So that you may fail in one case and succeed in another, and practically the one drug upon which we pin our faith is opium in one form or another.

Rôle of the Pancreas in Diabetes.—The pancreas is another gland that is closely associated with diabetes and glycosuria, and indeed it is probable that a good many cases of glycosuria are due to imperfect action of the pancreas. It is supposed that the pancreas not only pours a digestive juice into the duodenum, but pours out into the lymphatics a secretion which contains a glycolytic ferment. At the same time that the pancreas is pouring out into the duodenum a secretion which will convert starch into sugar, and will thus supply the body with sugar, it is pouring out into the circulation another ferment which can break up sugar so as to render it capable of combustion in the body, and thus enable the organism to utilise the sugar which is being absorbed from the intestine. It has been supposed that the want of this glycolytic ferment is the cause of glycosuria in many cases. I am just now trying the effect of pancreatic tabloids in a case of diabetes with the object of supplying this substance, but the treatment has not been continued long enough for me to say whether I shall succeed or not. Twenty-three years ago I attempted to supply a glycolytic ferment to diabetic patients by feeding them on raw meat, because I supposed that it was more likely to be present in the muscles than in any other part of the body. Therefore I administered muscle-flesh as a medicine and not merely as a food, and in order to prevent the destruction of the ferment, which would have occurred through cooking, I gave the meat raw.* I was not able to cure the patients by this method of treatment, and gave it up after a while. It is possible that if it were tried again more extensively good results would follow. At any rate, before many years have passed, I doubt not we shall be able to treat diabetes much more successfully than at present.

Action of Drugs on the Pancreas.—Now the pancreas may be stimulated by the introduction of food or of ether into the stomach, and it is affected by drugs very much in the same way as the salivary glands. Atropine paralyses the secretion both of the salivary glands and of the pancreas, and pilocarpine stimulates them both. Iodide of potassium tends to cause in many cases swelling of the salivary glands, but it does not seem, so far as I know, to have had any very distinct effect upon the pancreas. But one reason for this not having been noticed, I think, is that the pancreas lies so deep, and its functions are so difficult to discern from the outside that no observation has been made. On one occasion, however, after prescribing iodide of potassium to a patient, I was glad to see improvement within about three or four days, but afterwards he complained of pain in his abdomen, and, upon taking one finger and pressing all over the abdomen, I found, to my astonishment, that when I joined together the various points where he complained of pain on pressure I simply marked out upon his abdomen the outline of the pancreas. I therefore came to the conclusion that in this case the iodide of potassium had caused some tenderness of the pancreas, as it frequently does in the salivary glands.

There are some cases which you will meet with in your practice where the motions are of a perfectly white colour, almost

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* Lauder Brunton. "British Medical Journal," 1874. January 3, January 10, and February 21.

like arrowroot, and frequently they are not loose, but are rather tenacious, and form a curious rolled shape, almost like that of a snake coiled up and ready to strike. I saw one of these cases a number of years ago, and was very much astonished to find that the patient had no symptoms of jaundice whatever, and I wondered greatly what had become of the bile. There was no yellowness of the conjunctiva, no bile to be found in the urine, and apparently none to be found in the fæces, which were absolutely white, and I came to the conclusion that this man's liver must have struck work entirely. However, I had the fæces analysed, and then it was discovered that these white fæces, although apparently quite free from bile, actually did contain a considerable quantity of bile. The reason that they were white was, they contained a large quantity of the fat from the milk he had been taking. Although I did not get a post-mortem, because the man recovered, yet, comparing this case with others, I was inclined to think that the patient's pancreatic duct had got plugged, that there was no secretion coming from the pancreas, and so the fat remained quite untouched, and really covered over the bile which was present in the fæces. I really did not know very well what to do for this patient, but it was quite clear that all the fat he was taking in the milk was useless, so the first thing to do seemed to be to try and utilise the fat by giving the pancreatic juice which was absent. Now you know that to a great extent the pancreatic ferment is destroyed in the stomach, so that if you want to give the pancreatic ferment the best way is to administer it a good while after the meal, just about the time when the food will be leaving the stomach and passing into the duodenum. You may, perhaps, introduce the pancreatin still better into the bowel in a keratin capsule. Keratin is quite insoluble in the acid juices of the stomach, but is readily dissolved by the alkaline juice of the intestine. A very enterprising firm of druggists, at my suggestion, made a form of digestive tabloid which seems to be likely to be useful in such cases. The external part contains pepsin, and the internal part contains pancreatin, which is surrounded by a keratin capsule. The pepsin becomes dissolved in the stomach, and acts as a digestive ferment, while the pancreatin in its keratin capsule will pass through the pylorus with the food into the duodenum. In the case I have referred to maltine proved very useful by supplying to a great extent the diastatic ferment which ought normally to have been supplied by the pancreas.

We may now pass on to the question of treatment by foods, and amongst others to the milk diet, of which I have just been speaking. In that case the milk diet was to a considerable extent not utilised, because the pancreatic ferment was absent. In cases of weak digestion, we now partially digest the milk before it is taken by the admixture with it either of pepsin or pepsin and hydrochloric acid, or by the use of pancreas or of pancreatic tablets, which have come very much more into vogue of late years, because they are more convenient than mixtures containing acids and pepsin. When milk is not digested, in whole or in part, before it is given, it may be precipitated in the stomach in whitish flakes, which are not readily soluble. In digestion with pepsin, a bitter product seems to be formed to a larger extent than with pancreatin, although this may also yield a bitter product if the digestion be continued too long. Milk seems to contain in itself almost all the ingredients that are wanted for life, and a man may live upon milk for a long time without anything else. An exclusively milk diet, however, does not seem to be sufficient to keep a man in active work, but when he is lying in bed, as in cases of typhoid fever, we find that he progresses perfectly well on the milk diet. As I explained before, we frequently find that patients who cannot take milk when they are well and walking about take it perfectly well when they are confined to bed, especially when they have high fever, as in typhoid.

LECTURE 26.

Milk, *continued*—Importance of freshness—Constituents of a meal—Fats—Proteids—Carbohydrates—Salts—Digestibility and absorbibility of fat depend upon the state of mechanical division—Cod-liver oil—Salt constituents of body—Treatment of diabetes—Glycosuria and obesity—Bantingism—Salisbury's method—Proteids to be avoided—Uncertain forms of gout—Alcohol—Diet in Bright's disease—Diet in cardiac disease—Tonics—Weir Mitchell treatment—Hæmaturia—Different preparations of iron in anæmia—Pernicious anæmia—Treatment by bone marrow—Alteratives.

Gentlemen,

We were discussing at the end of last lecture the use of milk as an article of diet. I said that milk may be looked upon as an almost perfect article of diet, inasmuch as it contains the various substances requisite for the nutrition of the body, and in right proportion. The proportion at least is right for children; in adults you may find that the proportion needs to be varied, and even in children the proportion of ingredients contained in cow's milk does not always suit. In some cases also we find that the digestive power of the infant is insufficient, and we may require either to give along with the milk some substance that will enable the infant to digest it or else to digest the milk before it is taken into the stomach. The same thing holds good also for adults, and occasionally we are obliged, in place of giving crude milk, to peptonise it. Now you can readily see how very disadvantageous it will be either to a child or to an adult to have, in place of good, healthy milk, milk which has begun to undergo decomposition from the presence of bacteria in it. Occasionally people forget that milk which is to all appearances perfectly fresh may contain bacteria, and although one portion of the milk which is kept outside in a cool place may remain apparently sweet, yet another portion of the same milk when put into a warm stomach will undergo change, and will become sour or even putrid in a comparatively short time. I think I have seen a patient killed by milk given in this way. On smelling the milk which was put ready for the patient's use in a jug, one could readily notice that, although it was not what you would call sour, it was what is termed "on the turn." It was just beginning to get sour, and although, being kept outside the window, it had slowly undergone the change, yet after the patient drank it it became rapidly sour. The patient, who was suffering from pneumonia, got indigestion in addition, with great flatulence and hiccup; this interfered still further with his respiration, and he soon died. He might have died even if he had been fed upon perfectly good milk; but at any rate the sour milk appeared just to turn the balance and destroy his last chance of life. So it is well in cases where you are feeding patients with milk to be careful that it is fresh. There is some doubt as to whether it is advantageous to boil milk or not. To boil milk certainly tends to kill any bacteria in it and thus to lessen the chance of its becoming sour. On the other hand, boiled milk is not so pleasant to take, and with some people it does not agree so well. Boiled milk as a rule is said to be more constipating than fresh milk, and so it is frequently employed in cases where there is a good deal of diarrhœa; but if fresh milk be used properly it does not as a rule tend to cause diarrhœa, and in cases of the hill diarrhœa of India, which I have spoken of before, fresh milk is perhaps the better of the two. It would be very hard to keep patients upon boiled milk for three months, but I think you may keep them upon fresh milk for that time.

Now the constituents of the body as shown in milk, or perhaps, as they are more easily remembered, in an ordinary meal, may be said to be (1) proteids, (2) fats, (3) carbohydrates, and (4) salts. We shall have to refer to these not merely in connection with nutriment, but also with another class of drugs to which we shall pass presently: viz., the so-called alteratives. If you take an ordinary meal such as a man will get in the City you will find (1) the proteids are represented by a beefsteak or a mutton-chop; (2) the fats by the fat which is supplied along with the meat or by the butter which is usually given; (3) the carbohydrates by the bread or potato; and (4) the salts by the salt which is given in the salt-cellar and by the salts which are also contained to a large extent not only in the meat, but in the bread. A healthy man is able to utilise all those different parts of the food; but in certain cases we find that patients are perhaps unable to take a particular kind of food or to utilise it after they have got it. More especially do we find that many children and a considerable proportion of adults are unable to take fat, at least unless it is given in certain forms and with certain precautions. If any one of you were asked to swallow down a pat of butter, especially on a hot day and on an empty stomach, you might object and say it would make you sick, and possibly it might; but if you were to take that same pat of butter and spread it on a piece of bread it would not make you sick. The following question was once asked me by Professor Kronecker, of Berne: "Supposing you had a pat of butter and two pieces of bread to make a sandwich, how would you spread the butter so as to make it most palatable? Would you spread it just on one piece of bread and stick the other over it, or would you divide the butter into two parts and spread one on one-half of the sandwich and the other on the other half?" According to him, the butter would be most palatable if spread on both pieces of bread, because you thus get it in a finer state of division than if you spread it on one slice only, and it is the fine state of division of fat that frequently makes it digestible and palatable when it would be nauseous if taken in bulk. You know that a boy at school very often gets big bits of fat from boiled mutton which makes him sick, and if you happen to look at the vomited matters you will probably find the reason why. The hot mutton fat has run together, and you get great blobs of fat in the vomited matter. But that same boy could probably eat with perfect impunity and very likely with relish the same mutton fat if it were allowed to get cold, because when cold it becomes hard, so that when he eats it he is obliged to break it down thoroughly. Probably at the same time he would be eating a bit of bread with the mutton fat, and thus he would get it into a very fine state of division, so that he would digest it, and it would not make him sick at all. Therefore a fine state of division of the fat has a great deal to do with its digestibility, and whenever they get fat well divided people as a rule are able to digest it. In milk we find that fat forms very fine globules, separated from each other by a little membrane consisting of proteid matter which surrounds the globule. There seems, however, to be not only a certain difference in the mechanical conditions of fat, but a difference, to some extent, in the chemical nature of fats which makes one kind more readily digested and more readily assimilated than another. An old nurse when speaking to Weir Mitchell said: "Some fats is fast, and some fats is fleeting, but cod-liver oil fat is soon wasted." By this she meant that if you feed people upon certain fats they remain fat for a length of time, while other fats are more readily dissipated, and the plumpness they produce soon disappears. Cod-liver oil fat is soon fleeting, and a patient or a child that is rendered plump by feeding upon cod-liver oil soon gets thin if the administration of the fat be stopped. In all probability it is just this mobility, as one may term it, of cod-liver oil that makes it such an exceedingly good nutrient. It is readily put on, and it is readily put off, and between the time it is put on and put off it is probably quickly taken up by the cells of the tissues. In cases, for example, where a patient is suffering from chronic bronchitis, the cells of the lining membrane of the bronchial tubes are quickly thrown off, and although they multiply quickly, they do not get time to mature. Instead of forming regular epithelial cells, they are thrown off in the form of what one may term indifferently leucocytes, undifferentiated cells, or pus corpuscles, and one may say that the reason why they do not form regular cells is that they have not time to take in sufficient nutriment and to grow and develop. But if you supply such cells with fat which may be more readily taken in and assimilated than that which they usually get they may possibly grow into regular epithelial cells. Whether this be the case or not I cannot tell you, but practically you will find that the remedy *par excellence* not only for consumption, but for chronic bronchitis, is cod-liver oil. The patients in the casualty department of this Hospital, though they may have become perfectly weary of taking cough mixtures, will come again and again for cod-liver oil, because they say it eases their cough and lessens the phlegm at the same time; so that not only is the general condition of the patient improved, but the local condition of the respiratory passages also is greatly benefited by the cod-liver oil.

Amongst the proteids of food we have a large number of different classes of albumins, albumoses, and so on. The carbohydrates we have already been discussing under the heading of diabetes, and I have mentioned to you that diabetes is supposed to depend to a great extent upon the power of the liver to utilise the carbohydrates being lessened or destroyed. The salts we may take up more fully when considering "alteratives," because there is more known about the variation in salts than there is really in regard to the amount of salts circulating in the body. The chief salts in the body are chlorides, phosphates, and sulphates of sodium and potassium, the salts of sodium being chiefly present in the liquids, and the potash salts being present in the solids. You will remember this, perhaps, if we simply compare the body to the world at large, and regard the sea as the blood of the world and the solid land as its flesh and bones. We know that sodium chloride is the chief salt in sea-water, but potash salts prevail on land, land plants containing them to a large extent. The liquids of the body contain sodium; the solids of the body contain potassium; and we find that the potassium is present not merely in the solid organised tissues which are aggregated together, as in the muscles, but also in the solid parts of the blood, viz., the corpuscles, whereas it is chiefly sodium salts which are present in the plasma.

Now, in certain cases of disease, as I have mentioned, there is an inability to utilise carbohydrates, which pass out in the urine in the form of sugar, instead of being stored up for awhile in the body and then burnt off, passing away in the form of carbonic acid and water. This shows that there is an inability in the body to utilise carbohydrates, and, perhaps, I ought to say there is an inability in the body to oxidise them, because they ought to be oxidised into carbonic acid and water and thus to leave the organism. But the same inability to oxidise, to destroy, and utilise foods is shown in an inability to utilise proteids. You sometimes find that there is a want of power in certain individuals to utilise the carbohydrates at some periods and to utilise the proteids of food at others. This is very marked indeed in many cases of gout, where you find that at one time the gouty man passes a good deal of sugar in his urine, but the urine at that time is free from uric acid and is otherwise quite healthy. At another time the same man will pass no sugar in his urine, but he will pass a large quantity of uric or oxalic acid. You may find crystals of oxalate of lime, and say the man is suffering from oxaluria, or you may find a large quantity of uric acid, and say that the man is suffering from a uric acid diathesis or gout. In the same individual you may get alternations. Some of these gouty people have occasionally a great tendency to lay on flesh; they become enormously stout, and this is a condition that is frequently associated with an inability to utilise the carbohydrates. The man who is suffering, not from true diabetes, which is, as a rule, a wasting disease, but from gouty glycosuria, not only passes a large quantity of sugar in his urine, but lays on flesh to a tremendous extent. Sometimes you may find that flesh is laid on, and people become enormously stout, although they do not pass any sugar in their urine.

Treatment of Diabetes, Glycosuria, and Obesity.—Now the treatment for cases of diabetes or for gouty glycosuria is to give the patients only such foods as they can utilise and to cut off sugars and starches. You allow gouty glycosurics and diabetics fat *ad libitum.* In cases, however, of extreme obesity, whether it be connected with glycosuria or not, the treatment usually resolves itself into cutting off the carbohydrates and limiting or even cutting off the fats. Therefore, you see, the treatment for diabetes, glycosuria, and for obesity is very much the same, with the exception that the treatment for obesity is more strict than even for diabetes. The chief difference between the two is that, in addition to cutting off sugars and starches in a case of obesity, you cut off fat also, which you don't do in the case of a diabetic.

Banting's and Salisbury's Methods.—You can readily see, however, that this treatment really amounts to partial starvation. One of the means of reducing obesity is what is known under the name of "Bantingism," and that practically comes to be feeding almost entirely upon proteid diet: upon fish, flesh, fowl, and eggs, with perhaps a small quantity of green vegetables. This diet, I may say, is very fairly useful in reducing obesity, but it has one great disadvantage: that it is not a system of starvation only, but it leads to the accumulation in the body of the products of proteid waste. In consequence of this, it has been modified, and, I think, with advantage, by Salisbury, whose plan is to give, like Banting, a proteid diet, but at the same time to wash out the waste products that might otherwise tend to accumulate in the body by giving the patient large quantities of water. So that, in treating a very fat patient on the Salisbury plan, you give him meat, fish, flesh, fowl, and eggs, but an hour before each meal you tell him to drink a large tumbler of hot water. This treatment is often a very satisfactory one, and many patients are greatly delighted at the results, and it is a very good plan indeed, I think, for the treatment of very fat people, whether they be gouty or not.

But there are a lot of gouty people who are not fat; they are very thin, and in their case you must follow a different plan of treatment. It seems very odd that you should have two plans of treating gout absolutely dissimilar. One plan is that which I have mentioned of putting the patients upon a meat diet, plenty of all sorts of proteids, but cutting off sugars and starches. This does very well for the fat people, but not for the lean gouty people at all. In them you also limit the diet, but in a different direction. You limit the amount of proteid material, and try to put them as far as possible on a vegetarian diet. You see, the plan of treatment simply comes to this: that in both cases, in the fat and in the lean, there is an inability to utilise all the food, but in some of them the inability seems to extend chiefly to the sugars and fats, in others to the proteids. Therefore in the case of lean people suffering from gout you cut down their butcher's meat and give them plenty of fats and carbohydrates—really a vegetarian diet. In some cases of gout this answers very well indeed. Under the head of "vegetarian diet," however, one generally allows a certain latitude, and while you cut off the red meat, or cut it down to a minimum, you generally allow the patients fish and fowl, because in a great number of cases you find they simply will not go on without them; they must have some proteid material.

When speaking of alcohol, I mentioned that it had a tendency to lessen the processes of oxidation in the body, and, as a rule, in cases such as those I have mentioned, alcohol is disadvantageous. When people are cut off entirely from alcohol, they sometimes become so depressed that you are obliged to allow them something, and in such cases alcohol pure and simple, that is to say without the admixture of ethers or of salts such as we find in wines, is better than wine. We therefore allow them a little brandy, or a little whisky, with either plain water, or some effervescing water, and in cases of gout you frequently find that the use of alkali along with the water is advantageous. The alkalies that are chiefly used in gout are potash and lithia, the idea being that the potash salts of uric acid are more soluble than the soda salts, and so pass out of the body much more quickly. In the case of gout, however, as in a great many other troubles, a good deal of the mischief is due to the want of elimination; the patients do not drink enough water to remove the soluble residues of tissue waste from the body. These accumulate, and give rise to all sorts of discomforts, but by making the patient drink hot water at home, or sending him to such watering-places as Homburg, Baden-Baden, Wiesbaden, Carlsbad, Vichy, Aix-les-Bains, etc., where by getting baths and massage and drinking the waters, he gets his tissues well washed out, and comes home well.

Diet in Bright's Disease.—In cases of Bright's disease, we very often have to put the patient on a somewhat strict diet, in order to lessen the work which the kidney has to do as much as possible. This is done by prohibiting the patient from taking any strong soups, or any essence of meat, and by limiting the quantity of butcher's meat or eggs which he takes as much as practicable. The reason of this is that strong soup contains simply the extract of meat, and this, although a most useful stimulant, has very little nutritive power. It has all to pass out from the body through the kidney, and thus more work is put upon the kidney, to the disadvantage of the damaged organ. Cut these things I have mentioned out of the patient's dietary, and you lessen the substances that will produce urea. You must, however, give small quantities of proteids to supply the normal waste of the body, as well as to make up for any loss of albumin from the kidneys. But here you must draw a marked distinction between different forms of albuminuria. In some cases of albuminuria, you find that a large quantity of albumin is present in the urine, and then it will not do to cut off entirely the proteid matters from a patient's diet, because he will be much weakened unless this loss is made up to him somehow. But in cases of gouty kidney, where the elimination of solids is imperfect, and where the patient frequently passes large quantities of water of a very low specific gravity, you may cut the proteid matter down almost to a minimum, and the patient gains great advantage thereby. I was once called to see a patient for angina pectoris. He was a wealthy old man, with about £70,000 a year, and he had a doctor whose only care was to attend to him. I went down into the country, and when I saw the patient I said, "This is not angina pectoris; it is renal asthma." "But," said the doctor, "he has no albumin." On examining the urine, I found what I thought was likely to be there, viz., a very low specific gravity, and a very slight trace of albumin. I cut down the old gentleman's diet to less than that of a pauper, and fed him upon oatmeal porridge, bread and butter, and so on, cut off meat entirely, and the old gentleman improved very much. Unfortunately, I had just then a very severe attack of ague, and was obliged to go away, and shortly after I left town I heard that he was dead. I have very little doubt that it seemed to the doctor in attendance, and also to the man who was called in consultation afterwards, that it was very hard that this very rich old gentleman should be treated worse than a pauper, because his diet-table was a great deal less than that of a pauper. So long as he reduced the amount of food which he took to the level of what his kidneys could excrete, he remained well, but directly he took more than his kidneys could excrete he failed and died. You must draw this distinction between these two classes of albuminuria, and draw it pretty sharply.

Diet in Cardiac Disease.—Then, in cases of cardiac disease, you will sometimes find that a milk diet answers exceedingly well; that if you put a patient with bad mitral disease, failing heart, enlarged liver, and dropsical legs upon his back, and treat him precisely as you would a case of typhoid fever, you will get great improvement. One of the reasons for this appears to be that the lactose in the milk acts really, to a certain extent, as a diuretic, and that the patient, under the influence of rest along with this action of the lactose, passes abundance of urine, the dropsy diminishes, and the man becomes very much better.

Tonics.—Still in many cases we find that, whatever diet we put a man on, he does not recover; he continues to feel limp, low, and weak, and patients who have these feelings come to us and say, "Oh, doctor, I want a tonic." Now the name "tonic" comes from the string of a bow. When the string is drawn tight in the bow, then it is "in tone;" when it is loose, then it is "out of tone;" and the patient feels very much as a bow-string might be supposed to feel when it is unstrung, or, as a lady one day expressed it to me, and I thought very nicely, "she felt like a collar after all the starch had been taken out of it;" and what a tonic is wanted to do is, as it were, to put the starch into people again (Figs. 129, 130). A good deal of this feeling of lack of tone is not due to want of material in the body. We find that a fire burns low not only from want of coal, but still more frequently from getting choked up with ash, and if you want it to burn briskly, you do not merely throw coal on, but you take the poker and stir the ash out. In perhaps nine cases out of ten among your wealthier patients it is not the coal-scuttle that is wanted, but the poker, to clear out the waste products, and frequently a patient after a blue pill and a black draught, which have cleared away a lot of residue from the body, will feel a great deal brighter than if you had given him a bottle of champagne.

There are various classes of tonics, named according to the organ upon which they are supposed to act. We have, for example, gastric tonics acting upon the stomach; blood tonics, or hæmatinics, acting upon the blood; vascular tonics, acting upon the circulation; and nerve tonics, acting upon the general nervous system. Amongst the gastric tonics are those which increase the appetite or strengthen the digestion. More espe-

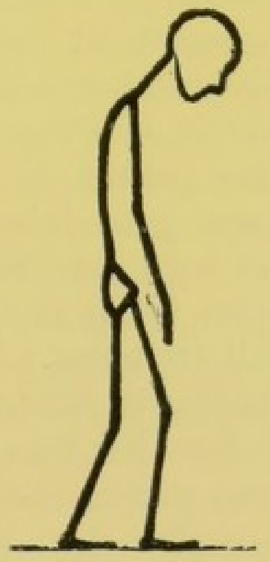

Fig. 129.—Before a tonic.

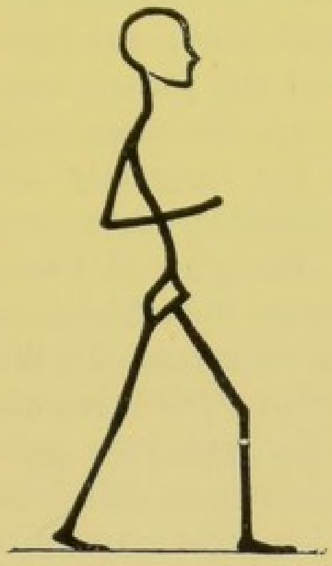

Fig. 130.—After a tonic.

cially we class as gastric tonics those that increase the appetite, and the chief amongst them are vegetable bitters, which, when given before meals, frequently cause a craving appetite. This we have already discussed. But along with vegetable bitters we frequently find that the addition of an acid, especially of nitro-hydrochloric acid, is useful, and one reason for this may be that nitro-hydrochloric acid, as I have before remarked, has an action upon the liver, and tends to increase the secretion of bile. Whether this is really so or not I cannot tell you, but there is no doubt whatever that this acid has got a great reputation as a tonic, and is a very efficient one. The haustus acidi nitro-hydrochlorici of our Hospital Pharmacopœia, especially when combined with 5 or 10 minims of the tincture of nux vomica, acts most satisfactorily as a tonic. Vascular tonics we have already discussed so thoroughly that at present, I think, we may pass them over; nervine tonics are those used where we wish to stimulate the nervous system, and more particularly, perhaps, the cerebral function, and the tonic *par excellence* in this department is nux vomica, or strychnine. Occasionally we find that various forms of phosphorus, and sometimes preparations of arsenic, are useful in this condition as well, especially in cases of prolonged nervous debility.

Weir Mitchell Treatment.—One of the most efficient methods of treatment of nervous debility, however, is that adopted by Weir Mitchell, and this simply consists in taking as little out of the patient and putting as much into him as you possibly can. In cases of general nervous debility, or neurasthenia, you frequently find that the patient is restless, perhaps irritable, does not sleep, and gets thinner and thinner. The plan of treatment there is to put the patient to bed away from friends, and isolation is one of the most important factors in the Weir Mitchell treatment. In cases where I have tried it without isolation, it has generally failed. You put your patient away from her friends with simply a nurse, or still better with two nurses, one for day and one for night; you give food at regular short intervals, and while keeping the patient in bed you supply the changes in the body which will lead to appetite by giving massage. Massage is a powerful tonic, because it takes the place of exercise for those who cannot take it. We all know that when a man is stout and out of sorts his friends often say to him: "Oh, if you would only go out and take plenty of exercise, you would get rid of all those uncomfortable feelings." But the patient often cannot take exercise. You get, for example, a big, flabby woman, about middle age, and you tell her to take exercise, and she says: "But, doctor, I cannot." Her muscles are not sufficient to carry her big, fat body about, and she is quite unable to take exercise. Then you get another patient who says: "I cannot take exercise because my heart is so weak. Whenever I take it, I have a pain in my side." That is quite true; he cannot take exercise. There are lots of others who can not, and there are a good many more who will not, and for them you supply exercise by means of massage, which, as I have before mentioned, consists in the twofold plan of kneading the muscles, so as to squeeze the waste products out of them, rubbing them on into the lymphatics, and then, in addition to kneading and rubbing, you may tap on the muscles or on the skin, so as to accelerate the flow of blood from the heart to the periphery, to the skin, and to the muscles. In this way you get all the vascular changes that occur during exercise without fatigue, and you give the patients the benefit of this exercise either when their skeletal muscles are too weak, or when their heart is too weak, to allow them to take it in the ordinary way. This plan of treatment also increases the red blood corpuscles, and in cases of anæmia we find that under massage and diet the patients improve greatly.

HÆMATINICS.—Red blood corpuscles contain proteid matter, fat, iron, and potash. Sometimes cod-liver oil tends to increase the formation of blood corpuscles, and so you get rid of anæmia, but amongst the so-called hæmatinics perhaps the most marked is iron in one of its various forms. The ancient Greeks, whenever they found a person was suffering from weakness and paleness, used to put a sword into a trough of water and then make the man drink the water. It was supposed that the sword had some sort of virtue of its own that entered into the man and gave him strength, and so it did, especially if it was well rusted. For if you put a piece of steel or iron into water it gradually does become rusted, and the steel steadily, though slowly, dissolves, and thus the water becomes ferruginous. The Greeks were quite right in their method of treatment, but as a rule we find this to be a rather slow process, and we usually prefer to give our patients some natural ferruginous water or various preparations of iron in the form of a pill or draught. One of the most favourite pills is the pilula ferri, which really contains carbonate of iron. There is in the Pharmacopœia an iron pill made with the carbonate—the pilula ferri carbonatis—in which saccharated carbonate of iron is formed first and then mixed with confection of roses and given to the patient. But this pill has not found so much favour as some other pills which are in the market. So in the last edition of the Pharmacopœia we have an attempt to imitate more nearly a formula which had been found practically to be very satisfactory in the treatment of anæmia, and you will notice that in the pilula ferri we have the sulphate of iron and the carbonate of potassium mixed together. When this is taken into the stomach there will probably be a reaction between those two. Whether it is just the small quantity of potash along with the iron that tends to supply another ingredient in the corpuscles I do not know, but the pilula ferri, such as we have in the last edition of the Pharmacopœia, is very satisfactory. In another of the older preparations, viz., the mistura ferri composita we also have a mixture of potash and iron. This is not to be confounded with another old preparation which is a good deal used, viz., the mistura ferri aromatica. The latter is interesting as being a preparation compounded according to rules which the student is told he must not follow. You are often asked at examinations what are the incompatibles of iron, and you are told in lectures and text-books that amongst them is tannin in any form, and very often people do not take the trouble to say why tannin is incompatible with iron. There is no real incompatibility; the two agree very well as far as the patient's treatment is concerned. The incompatibility consists in this, that if you mix tannin and iron, you get ink, and patients do not like to drink ink as a rule. Still we have in the Pharmacopœia a mixture which is known as mistura ferri aromatica, in which there is red cinchona bark, which yields tannin, and this along with the iron forms a tannate of iron, giving a black colour to the mixture which is often known as Heberden's ink. This mixture then really contains a tannate of iron as its essential ingredient.

Another favourite mixture is the one to which I have already referred, the mistura ferri composita, and which used to be known as Griffith's mixture. This contains, just like the pilula ferri, sulphate of iron and carbonate of potassium as its essential ingredients. Both the pill and the mixture are exceedingly good, but one of the best of all preparations of iron probably is what is known as steel drops; that is to say, a solution of the perchloride of iron either in the form of the liquor ferri perchloridi, which is a watery solution of the perchloride, or of the tinctura ferri perchloridi, which is an alcoholic solution. In the great mass of cases of anæmia which come to this Hospital, perhaps one of the most satisfactory medicines you can give is the haustus ferri cum quassia.* It is put in the Pharmacopœia as haustus ferri cum quassia, but you will always see it in the surgery as "H.Q.C.F.," the reason of the late alteration in the title being that the iron is the essential ingredient in the mixture, but still people, somehow or other, stick to the old name, and say "quassia and iron." We have here 15 minims of the solution of perchloride of iron and an ounce of the infusion of quassia. There are two infusions which do not give any black with iron, because they contain no tannin, viz., calumba and quassia, but one very frequently gives other infusions with iron. For example, one often gives infusion of gentian, and this becomes rather black, but still it is perfectly useful as a means of treatment.

There is another point that I must mention in regard to anæmia. In many cases you get good results from the administration of alkalies. A simple alkaline treatment often does the patient a great deal of good. I do not know whether it is by supplying alkalies to the blood, or improving the digestion, but very good results are obtained by using them in anæmia.

Pernicious Anæmia.—There is one form of anæmia which is usually regarded as incurable: the so-called pernicious anæmia, in which you find that the blood corpuscles are much altered in their shape and in resistance. They become less elastic, and are easily distorted; they diminish in number; and the patient gradually gets paler and paler, perhaps not much thinner, but weaker and weaker, and finally dies. This is looked upon as an absolutely incurable disease, and when a patient recovers after presenting the symptoms, people are apt to say that it could not have been pernicious anæmia, because if it had been he would have died. However, I have seen a case which presented the symptoms so markedly that everybody who saw the patient said, "This is a case of pernicious anæmia,

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* Haustus ferri cum quassia, St. Bartholomew's Hospital Pharmacopœia :—

Solution of perchloride of iron, 15 minims.
Infusion of quassia, to 1 ounce.

and the patient is sure to die." The patient did not die, and so possibly the diagnosis was wrong; but he was apparently going downhill as quickly as he could go, and everybody expected he would die in a few months. I advised that he should take beef marrow, and under this treatment he quickly recovered, and is now, I am glad to say, perfectly well. The idea of feeding a man on beef marrow was that the marrow is a substance in which blood corpuscles are formed. I forget at this moment who introduced it, but I think Professor Fraser, of Edinburgh, had a good deal to do with it, if not with the actual devising of the treatment. In the case I have just mentioned, the patient was not able to take the beef marrow; but an extract of it was administered, and this seemed to have the desired effect. When you are able to persuade the patient to take beef marrow, the best way is to make a little sandwich of thin toast—have it toasted pretty hard and have it pretty hot—and then spread the raw beef marrow between the pieces of toast. It then takes the place of butter, and the patient can get it down; but if you set a patient down before a marrow-bone with a spoon, before he is half through he begins to say he is sick of it, and will not have any more. The marrow-bone must not be roasted or cooked in any way, otherwise you destroy its effect. Where patients cannot take the raw marrow in this form, you may get them to take an extract of it. It may be rather doubtful as to whether this raw marrow is to be regarded as a hæmatinic, or whether it should be classed under another head: that of an alterative.

Alteratives.—By alteratives we mean those drugs which gradually alter and improve any morbid condition of the body without producing any evident external sign. If we give a dose of purgative medicine, we see that it is doing something; if we give a diuretic, we see that it is doing something; if we give an emetic, we see that it is doing something also, and we do not wonder so much that the patient recovers under the influence of such drugs. But if to men suffering, let us say, from rheumatism, we give iodide of potassium continuously, we do not see that the iodide is doing anything. It is not causing any greater evacuation of the bowels, it is not causing vomiting, it is not causing diuresis, and yet the patient's joints are gradually getting soft and more flexible under its use. There is no very evident external sign of the action of the drug, and yet it is making the patient better; so that those drugs which have this effect are known as alteratives. We may class the alteratives very much according to the different constituents of the body which they alter. We find in proteids, for example, that the most essential element is nitrogen, and you can readily see that if in every proteid we could replace either the whole or part of the nitrogen by some other element which would take its place, we should alter the constitution of the individual organs and tissues and the body generally. In the same way as we were speaking before of the fats, if we can replace a solid fat by one that is more labile we shall alter the constitution of those parts of the body which contain fat, and the same is the case with carbohydrates and with salts.

Now, nitrogen being the most important ingredient of proteids, we have various drugs which act as alteratives, and belonging to the same chemical group as nitrogen. For instance, in place of the nitrogen, we can put in phosphorus or arsenic, and both phosphorus and arsenic are very powerful alteratives. Perhaps more experiments have been made on the action of phosphorus than upon any other of the substitutes for nitrogen, and so we know rather more about the way in which it possibly acts as an alterative. You probably know that after phosphorus has been given either to an animal or to a man in poisonous doses, when the immediate irritant effects have passed off, secondary symptoms result. You will, perhaps, remember it more easily if I give you a case. In Vienna servant-girls sometimes wish to put an end to their lives, and the way they do it is this—they buy several boxes of lucifer matches, scrape off the heads, mix them with water, and then drink the contents of the tumbler. The first thing that happens to them is probably that they feel sick, get a pain in their stomach, and then vomit. The vomited matters often have a peculiar smell of phosphorus, and if seen in the dark are luminous. The patient is taken to the hospital, and, after vomiting for awhile, begins gradually to recover, the symptoms pass off, and people are inclined to think she has done herself no harm, but two or three days afterwards she begins to feel not so well. If the liver be then touched, it is found to be tender and enlarged, and then her face and eyes begin to get a yellowish tinge. Perhaps she vomits again, and before many days are over she becomes comatose and dies. The post-mortem examination is held, and then the liver is found to be excessively fatty and friable; the heart also, instead of being red and firm, as the heart ought to be, is perhaps almost entirely converted into fat; and you find the same tendency to fatty degeneration in all the various organs of the body. Now, Voit was very anxious to find out how this happened. He said: "Where does this fat all come from? It may have come," he thought, "from the food." So he got some dogs, and excluded this source of fallacy by giving them no food. He administered phosphorus, and still they died with fatty degeneration. Clearly the fat did not come from the food. Then it occurred to him that it might have come from other parts of the body, from which it might have been absorbed into the circulation and deposited in the liver and heart, so he not only gave the dogs no food, but kept them until the whole of the fat had been absorbed from the other parts of the body. He then gave phosphorus, and still they died, showing signs of fatty degeneration, as before. It was, evident, therefore that, as the fat had come neither from the food nor from other parts of the body by absorption, it must actually have been formed in the liver and in the heart, where it was found after death, by a transformation in the constituents of those organs. You know that when a body has been long under water the muscles are converted into a sort of fatty substance known as adipocere. It occurred to Voit that the fat in the liver and in the heart might be due either to increased formation of fat within the liver and heart from their proteid constituents, or to lessened combustion of fat thus formed, or to both. He thought that possibly fat was ordinarily formed in the heart and in the liver, and not burnt off when the animal was taking phosphorus. He first of all tested the amount of urea passed by the dog, and he found that it was enormously increased. It was quite plain then that the phosphorus had greatly increased the tissue change going on in the liver and in the heart and other organs. At the same time, however, he found that there was less oxygen taken up by the animal and less carbonic acid given out, so that the action of phosphorus upon the body was to diminish combustion, and, at the same time, to increase tissue change.

LECTURE 27.

Alteratives, *continued*—Nitrogen—Arsenic—Phosphorus—Animal organs and extracts—Myxœdema—Addison's disease—Exercise and massage as alteratives—Iodide of potassium as an alterative—Mercury—Antipyretics—Loss of heat by conduction, radiation, and evaporation—Acetate of ammonia, nitrous ether, and antimony—Quinine—Antipyrin—Antifebrin—Phenacetin—Diaphoretics and sudorifics—Turkish baths—Russian bath—Hot water internally—Antihydrotics—Relation of imperfect aëration of blood to sweating—Night sweats of phthisis.

Gentlemen,

We were considering last time the various substances which have a so-called alterative action, and I mentioned that alteratives take the place of certain constituents in the normal tissues, and by this replacement modify the processes of nutrition. One of the most important ingredients in the normal tissues is nitrogen, and its place can be taken by phosphorus, arsenic, or antimony. When phosphorus is administered to an animal it causes a large amount of fatty degeneration in the various organs and tissues of the body. These undergo fatty degeneration partly from increased transformation of proteids into fats, and partly from the diminished combustion of the fat which is thus formed. Now the fatty degeneration which is observed after the administration of phosphorus is a toxic action, but the same thing may be utilised in its lesser grades for its therapeutic action; for fatty degeneration is one of the means by which solid exudations are absorbed in the body, and we find that the administration of phosphorus or of arsenic in various forms tends to help the absorption of certain exudations. More especially is this noticeable in cases of catarrhal pneumonia, where the alveoli of the lungs, instead of being filled with fibrinous exudation and some leucocytes, become filled with proliferated epithelial cells. In ordinary pneumonia you would get during the inflammation an exudation simply of fibrinous material with some leucocytes, and this, although solid for several days, at the end of the fever quickly undergoes what is termed "resolution," or, I believe one might almost say, a process of self-digestion; so that this solid exudation becomes

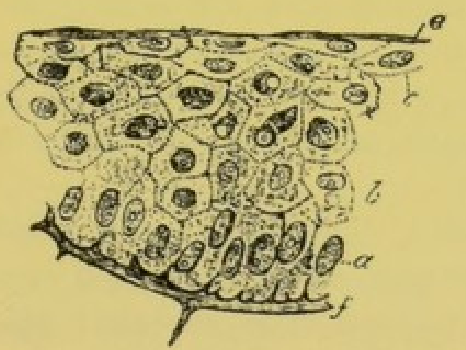

FIG. 131.—Vertical section of the healthy epidermis of a frog. *a*, columnar layer of cells; *b*, Malpighian layer; *c*, intermediate layer; *e*, corneous layer; *f*, sheet of connective tissue forming boundary between dermis and epidermis. (After Nunn.)

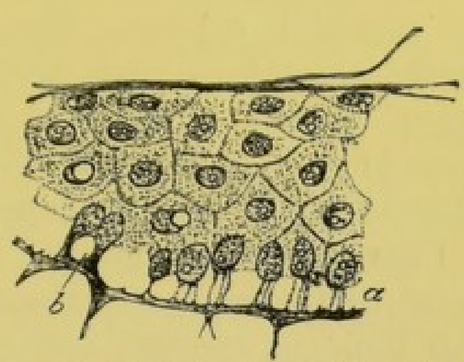

FIG. 132.—Vertical section of epidermis from a frog poisoned by arsenic. *b*, vacuole in the softened protoplasm of the columnar layer of cells. At *a* the protoplasm is more softened, and the vacuoles enlarged, so that the cells are attached to the dermis only by threads of protoplasm. (After Nunn.)

FIG. 133.—Section of lung, hardened in osmic acid, from guineapig poisoned by arsenious acid. The capillaries (*v*) project into the cavities of the alveoli, and are full of red blood corpuscles: the protoplasm (*a*) of the cells is filled with fatty granules; the nuclei are well preserved. (After Cornil.)

liquid again and is quickly absorbed. But in cases of catarrhal pneumonia, in place of this fibrinous exudation with leucocytes, we get a number of proliferated cells, which are very much more resistent, and which remain unchanged for a length of time without undergoing disintegration, solution, and absorption. The danger of this exudation remaining is that it affords a nidus for the tubercle bacilli, and the longer it remains in the lung the longer does the danger persist. Therefore one of our greatest desires in a case of broncho-pneumonia is to get rapid absorption of the substance which has been exuded, and for this purpose we try to hasten the processes of nature. In natural resolution, this exudation undergoes fatty degeneration, solution, and absorption. By giving such alteratives as will quicken the process, we lessen the danger of phthisis to which the patient is exposed. The substances that are usually employed are not so much phosphorus in its free form as the hypophosphites of lime and soda, which are very frequently given in cases of catarrhal pneumonia, and sometimes arsenic is administered for the same purpose.

I have already mentioned, I think, that phosphorus is not unfrequently employed for another purpose, viz., that of a cerebral tonic or cerebral nutrient, because it is supposed that phosphorus, forming, as it does, an important constituent of nervous tissue, is a useful nutrient in cases of nervous atony. Nitrogen, as I have said, may be replaced by arsenic, and probably this is to some extent the reason why arsenic is not only used to cause absorption in such cases as I have mentioned, but is frequently given as an alterative in gout and in the various forms of disease which owe their origin to a gouty substratum. Gouty people are very liable to suffer from various forms of disease, and you may find the different members of a gouty family all complaining of different things, and yet the whole of their symptoms are due to gout. One member of a family, for example, complains of gouty eczema, with irritation of the skin; a second complains of dyspepsia where there is no organic disease, but simply irritation in the stomach; a third complains of neuralgia, a fourth of asthma, where still you have nothing to see, only irritation; a fifth complains possibly of his liver or tendency to jaundice, a sixth of a tendency to pass uric acid gravel, with formation possibly of renal calculi or stone in the bladder; and a seventh may have well-marked gout in the toes. In all those cases you may find that arsenic is a useful remedy; and it seems very odd sometimes that one should use arsenic for so many diseases, all of which have apparently nothing whatever in common until we come to ask the question: "To what do they owe their origin?" and then we learn that they owe it to the gouty tendency. By altering the gouty tendency through the administration of arsenic, we are sometimes able to cure these different diseases.

ANIMAL ORGANS AND EXTRACTS.—But both phosphorus and arsenic sink into insignificance when we compare their power with that of some proteid substances themselves, because different proteids have an extraordinary power one over the other, and the health of the body appears to depend upon the proper adjustment of the proteids in its different parts. These proteids if set free in too large quantities at once from some organs would act as poisons to the body, while in small quantities they would tend to keep it in health. When we find that some part of the body becomes atrophied which usually ought to be functionally active, and to send through the body by means of the circulation various products of its functional activity, we are able in some cases to supply the material that ought to have been furnished by the atrophied gland.

Myxœdema.—The most marked example of this is probably the thyroid. When the thyroid is active, we find that the organism generally is healthy, unless there be some other reason for disease; but when the thyroid becomes atrophied, a very curious change takes place. The subcutaneous cellular tissue becomes filled with a sort of gelatinous substance nearly allied to that in the umbilical cord, and the accumulation of this substance gives rise to a very peculiar appearance of the patient. The face is swollen, the eyes are puffy, and from the swelling of the face the lips are thick and immobile, so that the patient has some difficulty in speaking. There is generally a very high colour just over the malar bones, but the rest of the face is pale and pasty-looking. At first sight you are apt to think that this is due to renal disease, but when you come to examine the urine you find, to your astonishment, that there is no albumin present. This condition is generally known by the name of myxœdema, and, till within the last few years, there was no remedy known for it. The remedy one used to employ was chloride of ammonium, which did a certain amount of good, but was only slightly curative. Now, however, by simply giving either the dry thyroid in the form of tablets, or a glycerine extract of the thyroid, we find that the symptoms of myxœdema quickly disappear; the fulness of the face diminishes, the patient regains his or her normal outline, the lips become thinner, much more mobile, the speech becomes easier, and the thickness and immobility of the hands, which are also symptoms of the disease, go away. As a rule, you find that this cure is not permanent, and that the administration of the thyroid requires to be kept up, but after you have got the patient into a fairly normal condition the return of the disease may be prevented by smaller doses. One could hardly expect that you would completely cure your patient without requiring to continue the medicine, because the gland is atrophied which ought normally to have gone on supplying this material to keep the tissue change in the body right. It no longer yields the material that is requisite for the proper nutrition of the body, and so necessarily you must, to a certain extent, go on supplying it artificially.

Addison's Disease.—There is another disease in which we find also a very marked change in the nutrition, viz., in disease and atrophy of the supra-renal capsules. In this disease the patient becomes exceedingly dark, patches of pigment are to be observed upon the mucous membranes, the weakness gradually increases, digestion becomes very poor, there is very often great and constant nausea and vomiting, and the patient gets weaker and weaker until finally he dies. For this disease there was formerly no remedy, and I do not know that we can say we have absolutely succeeded in getting one yet, but under the influence of tablets of supra-renal capsule the symptoms have in some cases, at least, appeared to become very much modified, and the patient very much better.

There are various other extracts that have been made from different parts of the body, and have been used in medicine. The most notable of those is extract of testicles, which was introduced first of all by Brown Sequard for general malnutrition and weakness. This substance appears to be not really a proteid, but an amine; but there is even now a considerable amount of discussion as to the chemical nature of the active principle of the extract of testicles. There is no doubt whatever that in some cases this extract really has a very powerful stimulating action, but its popularity is distinctly less than when it was first introduced by Brown Sequard. We have had also extracts of brain, which have been supposed to have a stimulating, and at the same time soothing, influence upon the nervous system. In cases of nervous weakness, where this weakness has either showed itself in languor and apathy, or, from want of inhibitory power as excitability, the extract of brain has been said to be useful. Extract of kidneys also has been employed in the treatment of kidney disease, and just now I am trying tablets of pancreas in the treatment of diabetes. Tablets of pancreas have been used before for the treatment of diabetes, but those that I have succeeded in getting made are on a somewhat different principle from the others. They contain a large quantity of a glycolytic ferment, and I have some hope that I shall thereby succeed in getting the sugar, which is not utilised by the diabetic, burnt up and used for the wants of the body. Its passage unchanged out of the body would thus be arrested. But none of these animal products seem to be able to hold their ground as remedies to the same extent as the thyroid, and certainly none of them have anything like such a marked action as the thyroid gland.

First Attempt at Organotherapy.—The practice of eating raw portions of animals, or of dead foes, in order to obtain certain faculties or remove morbid conditions, has prevailed from time immemorial amongst savage tribes, and the Bushmen of South Africa are accustomed, after killing a venomous snake, to swallow its poison, in order to render themselves immune from the effects of a bite. This practice of a tribe of savages has recently been shown by Fraser to be based on no mere fancy, but in all probability on careful observation, and to agree with the results of the most recent experiments on the subject of immunity from the effect of snake venom. All these practices may be looked upon as examples of organotherapy.

But the first instance in which portions of a raw organ have been scientifically administered to a patient with the view of curing a disease, as I mentioned in a lecture here some time ago,* was, I believe, the attempt I made in this Hospital, in the winter of 1873, to cure diabetes by the administration of raw meat. In the "British Medical Journal" for January 3, January 10, and February 21, 1874, I published some papers on the causes and treatment of diabetes, and showed that sugar is probably destroyed in the healthy muscles, and its appearance in the urine is due in certain cases to the want of the ferment by which it ought to be broken up and utilised in the muscles.

I may here give a few short extracts from the third of these papers ("British Medical Journal," February 21, 1874):—

"In view of these facts, we are, I think, justified in believing that the sugar which is present in the blood becomes converted by the aid of a ferment in the blood, muscles, and probably lungs also, into lactic acid and glycerine, and then undergoes combustion, thus sustaining the temperature of the body. Supposing, however, that this ferment is deficient, a greater or less proportion of the sugar will not undergo conversion into acid, and will then remain unconsumed, as in Ludwig and Scheremetjewski's experiment.

"Some time ago I tried to separate this ferment from muscles by Von Wittich's method, by glycerine, but was only partially successful.

"Several months ago I attempted to increase the decomposition of sugar in diabetics by supplying the ferment which I supposed to be wanting. Since sugar is probably decomposed chiefly in the muscles, the ferment which splits it up is probably contained to a much greater extent in them than in any other part of the body. By giving the patients raw meat, we may hope that the ferment contained in it will be absorbed from the intestine into the blood, and there act on the sugar. It is necessary that the meat be given raw, for the heat to which meat is exposed in cooking completely destroys all ferments. The patients on whom I tried this plan of treatment were under the care of Drs. Black, Andrew, and Duckworth; and I take this opportunity of expressing my thanks to these

* "Clinical Lecture on Diabetes, November 15, 1895." "St. Bartholomew's Hospital Journal," 1896, vol. 3, p. 66.

gentlemen for the readiness with which they afforded me the means of making observations and their kindness in supplying me with every facility, as well as to Messrs. Russell and Sawtell for the assistance they rendered me. The meat was finely chopped up in a sausage-machine, mixed with pepper and salt, and was either spread upon bread and butter, German fashion, or was made into a paste with bread and milk. Shortly after I began the treatment of one case, I learned from Dr. Duckworth that it had been tried empirically with complete success by the captain of a merchant vessel, who had prescribed for himself. In the cases treated in the Hospital, however, no cure was effected, although in certain of them there was some temporary benefit."

The reason for this failure probably is that the muscle ferment, or enzyme as it would now be called, is one of those which become changed in the intestinal canal or during absorption; and if one is to obtain any definite results it must be administered by subcutaneous injection. The great obstacle to this mode of treatment is that even now, after a lapse of 23 years, chemistry has not advanced any further in regard to the muscle enzyme than when I made my experiments, and does not yet enable us to separate the enzyme.

In one of the best and most recent books on physiological chemistry, by Neumeister, the author says, "Finally, the presence of an enzyme which forms lactic acid as well as of one which decomposes myosinogen, or forms myosin, may be inferred from the apparently spontaneous changes already described which occur in muscle plasm obtained by Kühne's method; but exact proof of the existence of these ferments is still required."*

EXERCISE AND MASSAGE AS ALTERATIVES.—Now you can readily

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* "Endlich lässt sich aus den eingangs mitgetheilten, scheinbar spontanen Veränderungen des Kühne'schen Muskelplasmas die Gegenwart eines Milchsäure bildenden, sowie eines Myosinogen zersetzenden oder Myosin bildenden Enzyms annehmen. Aber der exakte Beweis für die Existenz dieser Fermente ist vorläufig noch zu liefern" (Neumeister, "Lehrbuch der Physiologischen Chemie," Theil 2., s. 7, Jena, Gustav Fischer, 1895).

see that if in place of giving artificially an extract of a gland or of a part of the body, or by giving the substances that have been derived from it, whether these be of the nature of amines or alkaloids, we can manage to get from a part of the body which is still present in the organism more of its waste products than before, we shall alter the nutrition, not only of that part of the body from which we obtain these substances, but of the rest of the body as well. It is for this reason that exercise and massage are to be looked upon to a certain extent as alteratives, because by massage or exercise we remove from some parts of the body the waste products which they form, and which, by going to other parts of the body, modify the nutrition of them also. For example, if a man takes exercise, he forms in his muscles various waste products. These, if allowed to accumulate in the muscles themselves, are poisonous to the muscles, but when they pass on to other parts of the body they have a useful stimulating action. This is, of course, well known, because we are accustomed in cases of fever, and weakness, and debility to give to our patients the extract of muscle in the form of beef tea, and we find that it has a useful stimulating action. We may also get the extract of muscles removed from them and carried to the brain, where it will act as a stimulant, by putting our patients through a course of exercise, or by passively removing these substances from the muscles by means of massage, so that both exercise and massage are to be looked upon as useful methods of alterative treatment.

Iodide of Potassium as an Alterative.—We find further that by alterations in the salts of the body we are able to produce a marked alterative action as well. One of the most powerful alteratives in our possession is iodide of potassium. By its administration we alter the salts of the body in two ways. We increase the amount of potash as compared with the amount of soda, and potash by itself, either as an iodide, a carbonate, or a citrate, has got an alterative action, because we change the proportion of the potash in the body, and thus we modify the processes of tissue change. But the alteration produced by the administration of potash is comparatively small when compared with the alteration caused by the iodine.

In the normal body we have, as you know, a very large amount of chloride of sodium. If we replace the sodium by potassium and replace the chloride by iodine, we completely alter tissue change. Wherever we find, then, that there is a tendency to thickening in any of the fibrous tissues, we generally apply iodide of potassium. We use it as an alterative in rheumatism, and this is such an exceedingly common condition that iodide of potassium is very largely employed; we administer it for the chronic forms of rheumatism rather than for the acute, because in the latter, with high fever and pain, we usually give salicylate of soda. Iodide of potassium, however, is not only useful in removing the thickening due to chronic inflammation; it has a peculiar power of eliminating from the body various metallic salts which may have settled in it, for example salts of mercury and salts of lead. In cases of lead poisoning we give iodide of potassium, which, first of all, tends to form a soluble compound with the lead, and to bring it into the circulation; from the circulation it passes out of the body through the various eliminating channels. The same is the case with mercury when it has been given for a long time, and when iodide of potassium is administered it is found that a much larger proportion of the mercury may be observed in the urine than before. The reason is that here, as in the case of lead poisoning, a soluble compound has been formed between the mercury and the iodide, and the mercury that had previously been stored away in the solid tissues gets into the circulation, and is again eliminated.

Mercury.—There is a disease in which mercury is very much used, viz., syphilis. Mercury is generally employed in order to destroy the syphilitic virus, that is the syphilitic bacillus and its products, and thus to check infection. It is, therefore, given in the primary stage, that is to say shortly after the inoculation, when the primary sore is present, to destroy the bacilli; it is given in the secondary stages of the disease, when the mucous membranes and the skin are affected, and in which the bacilli are present and active; but it is not so much given in the later stages, say some years afterwards, because probably the bacilli are then all destroyed, and the conditions then present in the body are really the results of their previous action. For the removal of these we generally trust to iodide of potassium, but it has been noted that iodide of potassium alone sometimes does not succeed. When it has been given in cases of tertiary syphilis in which mercury had not been previously administered, it has been found to fail, whereas when subsequently combined with mercury it has succeeded. It is supposed, then, that in some of those cases of tertiary syphilis iodide of potassium does not act really by itself, but that it frees from the tissues mercury which has been lying dormant in them perhaps for many years, and that the good results which are certainly observed are due, not to the iodide of potassium alone, but to this drug plus the mercury.

Mercury has a very considerable power of destroying or breaking down recent fibrinous adhesions, and it is utilised to a certain extent in the treatment of adhesions in the eye. It used to be employed very largely in the treatment of pleurisy and pericarditis, where fibrous adhesions threatened to form between the two layers of the pleura or of the pericardium and thus to restrict the action of the lungs or heart. In cases of peritonitis it has been used to remove adhesions which would limit the action of the intestines. It has fallen very much into disuse, but, I think, rather undeservedly, and its disuse is due, like that of many other things, to its having been abused. It used to be given to such an extent as really to destroy the patient's health utterly; it was pushed on until profuse salivation was obtained, and at one time it was supposed that the more the patient was salivated the better was the result likely to be. This, we know, is untrue; we know that by continued salivation you simply weaken the patient without doing him very much good, and in all cases where you administer mercury the point to carry it to is simply until the gums shall begin to show a little soreness, and the flow of saliva to be slightly increased. A metallic, or, as patients sometimes call it, a coppery taste, a soreness of the gums, a stickiness of the teeth, a slight increase in the flow of saliva, and a disagreeable smell in the breath, are the indications that the physiological action of the mercury has been obtained, and whenever these are induced you stop the administration of the drug entirely, or greatly lessen the dose.

ANTIPYRETICS.—We may now pass on to another class of drugs, which is a very important one, viz., antipyretics. These are substances which lessen the temperature of the body, and more especially which bring down the raised temperature in fever.

We may lessen the amount of heat in the body by simply cooling it down by the application of external cold: by cold washing, cold sponging, or cold affusion, by which we mean sitting the patient in a bath and pouring cold water over him, or by leaving him in the bath with cold water, or by the application of ice-bags to various parts of the body. We may do it also by the simple use of cold air. In place of covering our patient with blankets, we may simply cover him with one sheet. Now you will find that a great many patients and their friends object to the use of a single sheet because they are afraid of catching cold, and no doubt there is a certain amount of truth in this objection. Even doctors have got a belief in their minds—and I think there is some reason for it—that sudden changes may, even in a feverish patient, tend occasionally to bring on a chill, with congestion of some internal organ, and therefore one does not like to run the risk of any chill. Whenever we get the patient's temperature rising very high, we simply take off all the clothes except a single blanket and just let him lie under a cradle, with the blanket kept off him by means of the cradle, so that it does not come into contact with the skin. Then you may have the end of the blanket not coming quite down to the end of the bed, and you thus get a more or less free current of air under the bedclothes, and the patient is kept fairly cool. Another way is to hang on to the cradle a little bag containing ice, so that as the ice melts the air under the cradle is kept cool.

But the loss of heat by conduction from the skin or by radiation is very slight compared with the loss of heat caused by evaporation, and so in cases of high fever you keep the patient's skin moist by simply sponging him all over and then putting the cradle on. In this way you get a considerable evaporation from the skin, and the patient's temperature is considerably reduced. Instead of making the skin moist by external application of water, you may make it moist from within by increasing the secretion of sweat, and this is very frequently done indeed. One of our most favourite remedies is acetate of ammonia, either alone or combined with various other things, and especially one of the best is spirit of nitrous ether. Half a drachm to one drachm of spirit of nitrous ether with half an ounce of the liquor ammoniæ acetatis, every two hours or so, forms a favourite mixture, and one of its advantages is that it does not pull down the temperature suddenly, as some of the newer febrifuges do, but simply cools the patients slowly and does not depress them in the way that some of the other drugs do. Another drug which tends to cause the skin to become moist is antimony, and antimony used to be used very commonly indeed in cases of high fever, although it is not nearly so much employed now. We have somehow got into the way of leaving it alone, more especially on account of its depressing tendency. Occasionally we find that a combination of opium with ipecacuanha answers well as a febrifuge, especially when there is a good deal of restlessness and sleeplessness present in the patient; 10 grains of compound ipecacuanha powder, or Dover's powder as it is usually called, given at night will sometimes enable a patient to throw off a feverish cold. Under the influence of the drug he falls asleep, the skin becomes moist, the cold disappears, and he awakes quite well the next morning.

Quinine and Coal-tar Products.—Some of the drugs which are used to lessen temperature are much more powerful in their action than those which I have just described. Amongst those generally employed is first of all quinine in large doses, which acts chiefly by lessening the production of heat. Then come various other products, antipyrin, phenacetin, etc., more or less allied to quinine in their chemical constitution, which act chiefly by increasing the loss of heat from the body. These have been obtained in consequence of the endeavours of chemists to make quinine artificially. When the price of quinine was sixteen shillings an ounce, it was quite clear that anybody who could produce it artificially would make a fortune, and many chemists attempted to do this. They failed to make quinine, but in the attempt to do so they came upon the aniline colours and various aromatic compounds; so that, although they cannot yet make quinine artificially, they have put in the market a great number of drugs which have a similar power to that of quinine, and some of them even surpass it in various respects. There is no drug yet that touches quinine as an antiperiodic, destroying the malarial poison; but various substitutes for quinine can reduce the temperature in fever more than it will do, and they have also the power of lessening the pain of neuralgia to a much greater extent than quinine itself. The chief substitutes that are employed are antipyrin, phenacetin, and antifebrin. Thallin, resorcin, and a great many others have also been introduced, but experience has shown that these are not so good as phenacetin, antipyrin, and antifebrin. We have some of these introduced into the Pharmacopœia. Antipyrin is a proprietary drug, and the framers of the Pharmacopœia objected to put in the names of proprietary substances, so they called it phenazon. It is generally known, however, by the name antipyrin. There is a certain advantage in the name phenazon, for sometimes you are able to prescribe it to patients who are unaware that it is the same as antipyrin, which is known by everybody, and is much used without reference to a medical man. Sometimes when you wish to prescribe it the patients say they are afraid to take it, because it lowers the action of the heart, but you know it will do them good, and you prescribe it under the name phenazon.

Phenacetin is a drug that has an action very much like that of antipyrin, but it is less soluble and less depressing. All these drugs have the power of depressing the action of the heart, and in large doses they may prove dangerous. In addition to this, they lower the temperature so quickly that they take away rapidly from the heart the stimulus which is given to it by the warm blood which is circulating through it. I showed you before that if you cool a heart down you slow the beats and render them more feeble, and by rapidly reducing the temperature of the body you tend to weaken the heart, and so when large doses of these drugs have been given they tend sometimes to produce a condition of collapse. All of them have a tendency to alter the constitution of the blood, and in very large doses they may produce a curious condition in which a good deal of methæmaglobin and perhaps hæmatin is formed, with a tendency to lividity. Curiously enough, most of the cases of collapse that have been observed from the administration of moderate doses of antipyrin have been in women during the menstrual period. It would almost seem as if during this period there is such a change in the nutrition of the woman's organism that antipyrin and phenacetin seem to act more quickly upon the blood and to produce methæmaglobin ; so it is well to be careful about the administration of these antipyretics in cases where a woman is menstruating. In addition to their power of lowering the temperature by their action upon either the tissues or the regulating centres in the brain which lower the temperature, they cause increased secretion of sweat, and sometimes this secretion, which is usually advantageous by tending to lower the temperature, is disagreeable to the patient.

Diaphoretics and Sudorifics.—The drugs which cause a slight stimulation of the sweat glands and a slight increase in the secretion of sweat are called "Diaphoretics," but when they cause sweat to pour out from the glands, and render the body wet instead of merely moist, they are termed "Sudorifics." One of the most rapid sudorifics is probably hot air, and in cases where you wish to get the sweat glands to act very rapidly you put the patient in a hot air bath. Here also we find that the application of hot air has a useful general action and many people who suffer from gout or rheumatism are greatly benefited by a Turkish bath, say once or twice a week. In a Turkish bath the bather goes into a dressing-room, where he removes his clothes and girds a towel round his loins. From this he passes into the first warm room, where he sits down and has a glass or two of water brought to him, which he drinks. Under the influence of the water internally and the hot air externally, he begins to perspire, but if he does not do so, he generally goes on into a warmer room still and stays there until the sweat begins to burst forth. He then goes back to the first warm room, where, after sitting for awhile, he is subjected to a certain amount of massage, and then either douched with tepid water or put into a plunge-bath. In this country the plunge-bath is more generally used, but in some other countries the cold bath is not used. They simply give you a tepid douche, and then, having dried you, lay you out in the dressing-room, to remain quiet for awhile before putting on your clothes again. The effect of the bath is usually to soothe the nerves, to increase muscular power, and to lessen any pains that may be present in the joints.

Now, the skin and the kidneys have a sort of complementary action. The more water the skin excretes, the less are the kidneys called upon to eliminate. In cases where the kidneys tend to be inactive we supplement their action by increasing that of the skin; in cases of renal disease you frequently use sudorifics in order to remove water from the body. You may put a patient suffering from kidney disease into a hot air bath, such as the Turkish bath, or you may employ a hot air bath by simply putting the patient into a kind of box, which is closed up to the neck, and in which you have hot air placed, or, in place of this, you may seat the patient upon a chair, and put underneath it a small spirit lamp, covering both patient and lamp with a blanket, so that the air under it is gradually warmed, and the patient begins to perspire. When he is confined to bed you frequently use the cradle, and hot air is passed in under the cradle from a special apparatus. When this cannot be obtained, a spirit lamp may be placed just over the feet, but care must be taken lest the clothes get on fire. Another way is occasionally to pass steam in from one of the ordinary bronchitis or croup kettles, and this has the effect, at the same time, of moistening the air, and so tending to cause the skin to act.

There is another form of bath that is sometimes used, and is known as the Russian bath; but this is a much more trying form of bath than the Turkish. In the Turkish you have hot air, but it is dry; in the Russian bath you have steam. In some of the Russian baths on the Continent you have to go up a series of steps, and as you ascend the air gets hotter and hotter, and sometimes, after you have got past the first or second step, you cannot breathe until you get a sponge dipped in cold water and hold it over your nose. Under the influence of the hot vapour, perspiration is brought on freely. After awhile you are taken out, and quite cold water is thrown upon you. In Russia, I believe, they throw some sort of cover round them, and have a kettle steaming underneath it. After getting themselves into a state of profuse perspiration, they are accustomed to rush out and roll themselves in the snow, and then go back again to where the steam is generated. This bath has much to recommend it, but it is more trying and much less agreeable than the Turkish bath.

Hot water taken internally frequently causes the skin to act very freely. Salts of ammonia have a powerful diaphoretic action, and one of the most common that we use is acetate of ammonia, which I have already mentioned as being a useful febrifuge. Another thing that sometimes tends to cause action of the sweat glands is alcohol in various forms, but the action of alcohol is much less than that of spirit of nitrous ether, which has simply the effect of dilating the vessels generally, but if the dilatation of some vessels is assisted by local applications, the nitrite affects them more than others. If we keep the skin warm, spirit of nitrous ether will dilate the cutaneous vessels, and will act as a diaphoretic; if the skin be cold, the nitrous ether will again dilate the vessels generally, but it will affect the vessels, not of the skin, but of the internal organs, and especially those of the kidneys. Thus more blood passes to the interior of the body, and less to the skin, and so, instead of increasing the secretion of sweat, the spirit of nitrous ether increases the action of the kidneys, and thus acts as a diuretic.

Pilocarpine is a drug which has the power of stimulating the secretion from the sweat glands, and it acts upon them frequently by stimulating the ends of the secreting nerves. It acts also upon other glands in the same way.

Antihydrotics.—We will now pass to another class of drugs: those that tend to stop secretion of sweat; and these are called "Antihydrotics" or "Anhydrotics." The secretion of sweat sometimes becomes so excessive as to be exceedingly disagreeable to the patient, and you will find that many patients are under the impression that sweating is a very weakening thing. But you all know that if a man goes into the cricket field or on to the football ground and sweats profusely, it does not weaken him. If he be weakened at all, it is not by sweating; it is by the over-exertion which caused the sweating. Now, it is the same thing in disease. You will find that patients, and perhaps some doctors, are under the belief that sweating in phthisis is an exhausting thing. There can be no doubt whatever that if a phthisical patient awakes early in the morning sweating profusely, he feels very weak. But it is not the sweating that causes this; it is the condition of the patient that has led both to the sweating and to the weakness. Now, in order to understand why a patient should feel so weak, we had better consider why people sweat at all. Usually the secretion of sweat is started by stimulation of the nerves which supply the glands. The nerve centres from which the nerves proceed, and from which the stimuli to them originate, are situated in the spinal cord. One of the most powerful stimulants of all nervous tissue is a venous condition of blood, but ordinarily the part of the nervous system which is most sensitive to this stimulus is the respiratory centre in the medulla oblongata. As soon as the blood which circulates in the healthy medulla begins to become venous in the slightest degree, the respiratory centre responds immediately to the stimulus, the respiratory movements become deeper or quicker, the absorption of oxygen and elimination of carbonic acid are increased, and the blood is brought to its normal condition again. When the respiratory centre is dulled by drugs or by fatigue, it does not respond to the stimulus of venous blood, and you find that as the blood becomes more and more venous other centres get stimulated.

Perhaps the very best description that was ever given of the action of opium was written many hundred years before the Christian era by an old Greek, Nicander, of Colophon, who describes in most characteristic language how the opium caused the patient to become quiet, and how the movements of respiration became feeble, the red face became livid, and the drops of sweat stood upon the forehead. If any of you have had occasion to watch a patient die, you will have noticed that the so-called death-dews, the drops of sweat upon the forehead, appear just at the time that the nails begin to turn bluish, and the lobes of the ears and lips become livid. The reason is that the respiratory centre is failing, and even the powerful stimulation it receives from the venous blood circulating in it is unable to bring it up to its normal activity; consequently the respiratory movements are not increased, and

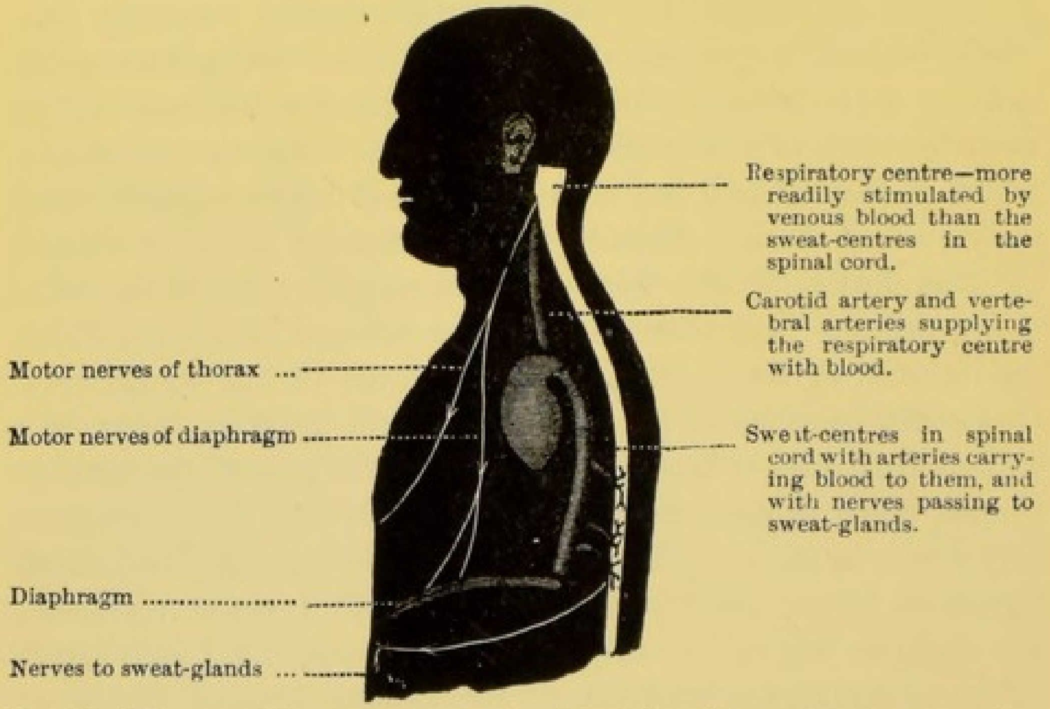

FIG. 134.—Diagram to illustrate the action of antihydrotics. The secretory nerves passing to the sweat-glands from the sweat-centres in the spinal cord have been represented as a single nerve for the sake of simplicity.

the venous blood stimulates other nerve centres which are usually less sensitive to it than the respiratory centre is. Amongst these is the sweat centre in the spinal cord, so that in healthy persons in whom the respiratory centre is dulled by opium, or in dying persons, where the respiratory centre is failing, the increased venosity of the blood will bring on a profuse secretion of sweat. This secretion is due to stimulation of the secreting cells through their nerves, and is quite apart from any increased supply of blood. When a man is playing in a football match or in the cricket field, the secretion of sweat is usually accompanied by a flow of blood to the skin which supplies the materials for the secretion of sweat, but this increased flow is not necessary, and the secretion may take place without it.

Now you can readily see that in ordinary people when they go to sleep the respiratory centre is no more feeble than the other centres, and so, although it may require a somewhat increased stimulus to act, yet it still retains its normal place in relation to other nerve centres, and will answer to the stimulus of venous blood sooner than they. But in a patient who is suffering from phthisis, where there has been a good deal of cough, and where the respiratory centre has consequently been undergoing excessive stimulation during the day, it will get more tired, and so during the night the respiratory centre may not react to the increased amount of carbonic acid in the blood in the way that it ought to do, and then the patient will awake sweating profusely. It occurred to me that if this explanation of the sweating in phthisis were correct, one ought to be able to stop the secretion of sweat, and also prevent the weakness which usually accompanies it by the administration of a powerful respiratory stimulant just before the patient goes to bed. I accordingly tried strychnine, which I thought ought to act, and I found that by giving it I could arrest the secretion of sweat in phthisis and stop the debility which usually accompanies it. At the same time, strychnine had a disagreeable action in this way: that its stimulating effect upon the respiratory centre remained during the day, and so, the respiratory centre being more easily acted upon, the irritation in the lungs caused more cough, so that, although the sweats were stopped, the use of strychnine was not without its drawbacks.

LECTURE 28.

Antihydrotics, *continued*—Atropine—Diaphoresis and diuresis complementary—Selective action of kidney—Relation of structure of kidney to its function—Action of drugs on the kidney—Three kinds of diuretics—Cardio-vascular tonics and vaso-dilators both diuretics—Caffeine—Uses of diuretics—Paracentesis abdominis and purgation Adjuvants to diuretics—Albuminuria—Lithæmia—Direct and indirect alkalies—Hydrotherapy of lithæmia—Contrexéville—Wildungen.

GENTLEMEN,

At the end of the last lecture I told you that the administration of strychnine, or nux vomica, at bed-time stopped the night sweats in phthisis, but had the disadvantage of increasing the cough during the day. In order to lessen this untoward effect, I combined some opium with the strychnine, but upon the whole I did not find that even this combination was quite so useful as atropine, which is the drug upon which we chiefly pin our faith in cases of sweating in phthisis. Atropine has the most powerful action of almost any drug we know in stopping the secretion of sweat, because it paralyses the ends of the secreting nerves in the sweat glands, and in consequence of this the skin becomes completely dry. But atropine has another action: it is a central stimulant at the same time that it is a peripheral paralysant, and it stimulates the centre for respiration; it also lessens irritability of the nerves proceeding from the lungs to the respiratory centre. It is thus a very useful drug indeed in cases of phthisis, tending to lessen both cough and sweating. We generally give it in small doses in the form of a pill, and you will find that there is in our Hospital Pharmacopœia a pill which is commonly prescribed in cases of night sweat in phthisis. This is the pilula atropinæ,* which

* Atropine, gr. $\frac{1}{200}$.
Spirit Rectified, $\frac{1}{20}$ minim.
Liquorice Powder, 2 grains.
Treacle, a sufficiency.

contains only $\frac{1}{200}$th of a grain of atropine made up with rectified spirit, liquorice powder, and treacle. It does not matter very much how the pill is made up, but you should notice that the dose of atropine is a very small one. If you give more than $\frac{1}{200}$th of a grain you are apt to get disagreeable results, viz., the atropine, instead of limiting its action to the part of the body which you desire, acts upon other parts as well. In consequence of this, you get not merely stoppage of the sweat, but stoppage of the saliva, making the mouth dry and giving the patient great discomfort. The dryness of the mouth is not only uncomfortable, but it leads to a condition of thirst, so that the patient wishes to be frequently drinking. At the same time the patient may have a slight difficulty in swallowing. Sometimes you will notice that this small dose of atropine does not act the first night after you have given it, but you get the sweats stopping the night after. This would appear to show that the action of atropine is not due merely to a paralysing action upon the ends of the secreting nerves in the sudoriparous glands, because if it were so you ought to get the action of the atropine most marked within a few hours after it had been administered, and yet perhaps it is 24 hours afterwards that you get the action most marked. Therefore it seems that the action of atropine in stopping the secretion of sweat is not a direct one, but is rather an indirect one, and we may suppose that it is to a great extent due to a stimulating effect upon the respiratory centre. Whether this be so or not, there is one thing to be borne in mind, which is that atropine is the drug that you generally employ in cases of night sweats in phthisis. Many substitutes have been employed, but atropine still holds its own as being the most satisfactory. If you find that in certain cases the salivary glands are too much affected by it, so that you cannot stop the sweat without stopping also the saliva and rendering your patient very uncomfortable, you can have recourse to other drugs; that is to say, you may use such drugs as I have mentioned, a combination of strychnine and opium, or you may employ Dover's powder, which, although a sudorific in healthy people, tends to check night sweat in phthisis probably in the same way as the mixture of strychnine and opium. The reason appears to be that in Dover's powder (compound ipecacuanha powder) we have a combination of opium with ipecacuanha, which, as you know, is an emetic, and powerfully stimulates the respiratory centre and the vomiting centre as well. In small doses ipecacuanha stimulates the respiratory centre, which is a part of the vomiting centre. When you give it in larger doses its influence spreads over a greater area in the medulla, stimulating the whole of the vomiting centre and causing brisk emesis; so that the active principle of ipecacuanha has got the name of emetin.

Another condition that is apt to bring about sweating, as everybody knows, is increased temperature. Now increased temperature in phthisical patients, as in others, is apt to bring about sweating, and it is just possible that in some cases you may find that the rise of temperature coincides with the sweating, or perhaps I should say that a pretty sharp rise of temperature precedes the sweating, and that the sweat brings down the temperature. In all those cases you must bear in mind that the sweat may to a certain extent be beneficial by allowing the excess of heat to be eliminated from the body by evaporation, and that the sweating is thus a natural termination to the fever which we frequently find in cases of phthisis; so that it is not advisable to check the sweating completely in every case. But you may check the sweating in such cases indirectly, not by giving a regular anhydrotic, but by giving an antipyretic, such as quinine. This will, in cases of phthisis where the sweating is severe and is preceded by a sharp rise of temperature, prevent the sweating by preventing the rise of temperature. Antipyrin or phenacetin may also be used for the same purpose.

Now it may seem here as if we were blowing hot and cold, because antipyrin and phenacetin are both powerful diaphoretics, and of themselves tend to cause diaphoresis in healthy persons, and yet you know they check sweating in phthisis. The reason is simply this: you are not giving those drugs in phthisis for their action on the sweat glands; you are giving them as antipyretics when the rise of temperature begins, in order to prevent it from rising so high as it would otherwise do, and by thus checking the fever you prevent the sweating which it would induce. You, as it were, keep the temperature down by allowing gentle diaphoresis to go on for a length of time instead of allowing great sweating to go on for a short time. So that in cases of phthisis, or in cases of any other fevers, you may check the sweating by checking the rise of temperature.

Diuresis and Diaphoresis Complementary.—Now, as I mentioned to you before, the kidney and the skin have functions which are complementary to one another, because when one does a great deal the other does less, and if we can throw more work upon the skin, we throw less upon the kidney, and *vice versâ.* The kidney has got a most important function to fulfil, because through it the products of tissue waste are chiefly eliminated. Of course we have a small amount of tissue waste eliminated by the skin. You do find a certain quantity of urea in the sweat, especially under conditions where the kidney is working insufficiently, but the amount of solids eliminated by the skin is small. The skin chiefly acts by eliminating water and by regulating temperature through the evaporation of this water. The function of the kidney is to eliminate water and the products of tissue waste. But it has not only to eliminate water and to eliminate solids: it has to eliminate them in varying proportions, regulated according to the needs of the body. Supposing a man is taking a walk on a hot day, the exercise of walking causes increased production of heat in the body, along with increased formation of muscular waste. Under such conditions, a good deal of water is necessarily lost by the skin in the mere effort of nature to keep down the temperature of the body. But if so much has gone off by the skin, and the supply of drinking water is scanty, so that he cannot get very much to drink, what is to become of his tissue waste? The muscles are doing three things. They are not merely conveying the man over the ground, but in the process of doing so they are generating an amount of heat which, if it were prevented from radiating or being conveyed off from the body in other ways, would raise the body to a fever temperature, and might kill the man. At the same time, they are generating products of waste which, if they were to accumulate in the body, would certainly prove injurious. So he has to keep down the temperature, and this he does by the skin, by radiation and evaporation; he has to eliminate the products of his waste, and, as the skin does not do this sufficiently, he has to do it by means of his kidneys. But if he has little water, barely sufficient to supply his skin, and if his kidneys were to excrete a lot of water at the same time, the consequence would be that the man would soon become excessively thirsty, his tissues would be deprived of water, and he would become ill, or even die. To prevent such a catastrophe, it is necessary for the kidneys under such circumstances to excrete a large quantity of solids in proportion to the water. They have to excrete the solids, but they have to retain the water, and when you examine the urine passed by a man under such conditions you will find that it is high-coloured, of very high specific gravity, and contains an exceedingly large proportion of solids.

Let the same man take a walk on a cold winter's day. He loses much heat by radiation and conduction, does not require to lose much heat from the skin by evaporation, but he wants to get rid both of water and of the products of tissue waste. Let us suppose that just before he has started he has taken a good breakfast, including several large cups of coffee. He wants to get rid of the excess of water and tissue waste; the skin will not do very much to help him here, because it is a cold day, the evaporation from the skin is very slight, and the whole has to get out of the kidneys. Here, therefore, he has to pass urine containing not only a certain proportion of solids, but a large amount of water. Sometimes, therefore, a man has to excrete a lot of solids and little water, at other times a lot of water and little solids. Well, we have got a curious arrangement in the kidney for meeting these difficulties, but there is one more difficulty that the kidney has to surmount. I have spoken just now only of water and solids, but the kidney must not excrete all solids equally, for sometimes one kind of solid is in excess, and another is scanty. One day, for example, a man takes a lot of lemon squash, and in the lemon squash he has got a lot of citrate of potash. He is thirsty, and perhaps drinks a good deal of it, so that he ingests a lot of potash. The kidney has to select from the salts brought to it by the blood and put out more potash than soda that day. Another day, instead of lemon squash, the man takes a lot of hot soup, and adds salt, *i.e.*, sodium chloride, to it; that day he ingests more sodium, and the kidney has to make a different selection, and to pass out a larger proportion of sodium than of potash. The kidney, therefore, has to make a selection, sometimes to excrete much water, sometimes much solids, and at other times to make a selection amongst the solids. Not only has it to select between the different kinds of inorganic salts, but it has to select between the various organic products that are presented to it. So, you see, it is a very complicated function that the kidney has to perform, and we find that it has a very complicated structure. It will make the matter clearer to you if I give you a simple sketch. The artery conveying the blood to the kidney (Fig. 135) breaks up into a number of capillaries, and from these comes a vein. These capillaries seem to act the part of a large filter, and here, just as you would put an ordinary filter into a funnel, so this filter (the glomerulus) is put into a funnel, which is the capsule. From this we have a tube passing, which is elongated and narrow, so as to present a considerable resistance to the passage of fluid along it. Fluid is excreted from the capillaries of the glomerulus, and then passes along through the tube, but, as you see, there is a considerable resistance opposed to its flow, so that there is a good deal of time afforded for re-absorption of water in cases where this may be necessary. If the pressure be great the water will rush rapidly through, and there will be little time for re-absorption, so that the urine which will be excreted when there is a high pressure in the glomerulus and abundant transudation through its capillaries will be of low specific gravity, and will contain a large proportion of water and a small proportion of solids. But as the urine passes through the tubules the water is partly re-absorbed, and probably there is partly also an alteration in its composition from further excretion of solids as well as absorption of water. The two parts of the kidney have got a blood supply of different kinds. The blood in the glomerulus has been altered in its composition by a lot of watery fluid exuding from it, so that the blood which passes out into the vein is very considerably more concentrated, and is somewhat different in its composition from what was present in the

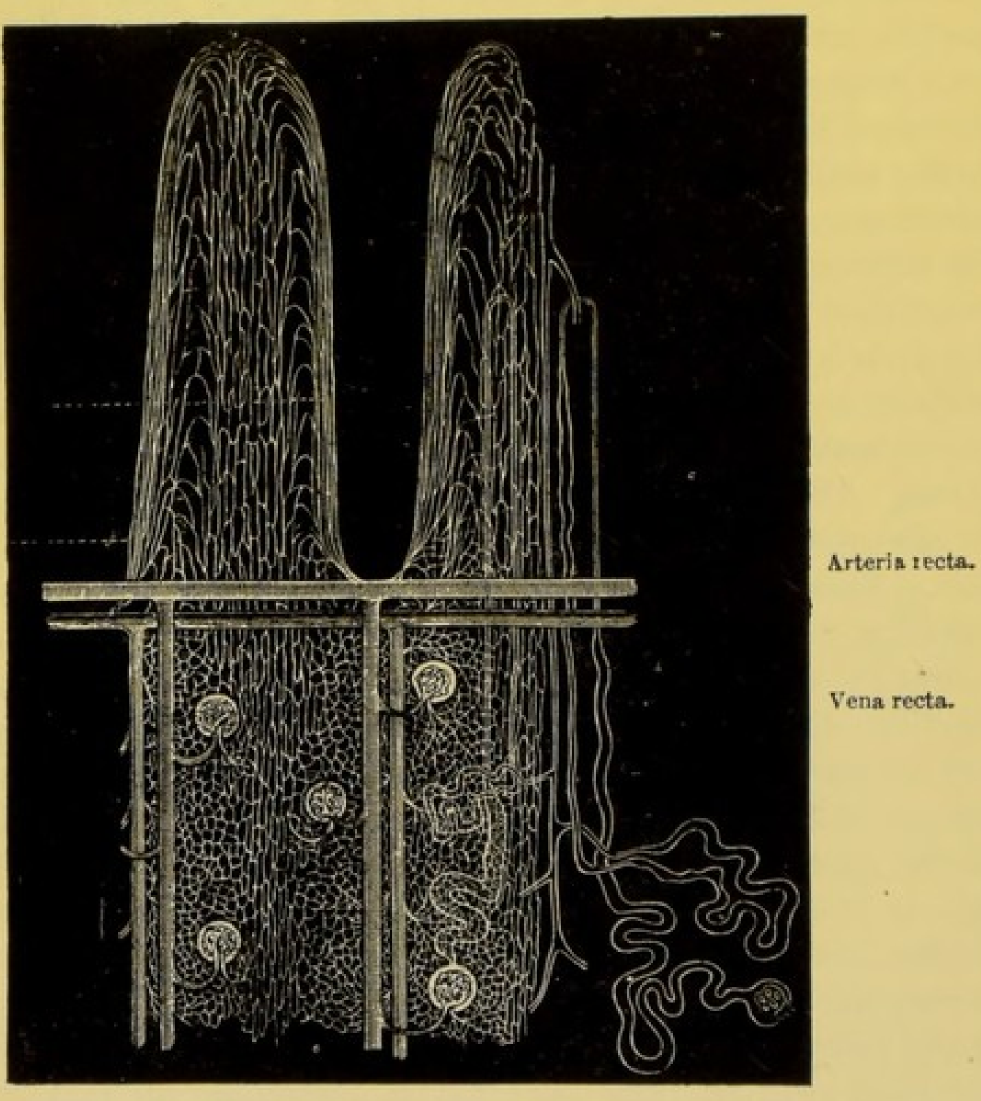

FIG. 135.—Blood supply and tubules of the kidney.

glomerulus. This venous blood goes circulating around the tubules of the kidney, and from the venous blood apparently substances are taken up by the cells of the tubules and excreted into the tubules, while, at the same time, it is probable that other substances are taken up from the tubules and returned into the venous blood. We have further in the vasa recta an arrangement by which both solids and water can reach the tubules, and thus supply material for secretion, or absorb from them without going through the glomeruli at all. You see then, that in the kidney we have a complicated apparatus which excretes water when it is too abundant, and which retains water in the body where it is necessary, and yet allows of the solids passing out. We have at the same time an apparatus for the selection and excretion of solids.

Action of Drugs upon the Kidney.—Sometimes we wish to cause an excretion of water, and sometimes an excretion of solids ; occasionally we wish to do both. The drugs which we use in order to cause increased secretion by the kidneys are termed "Diuretics," and we have three classes of diuretics, just as you might expect, viz. :—

1. Those which act upon the blood.
2. Those which act upon the circulation.
3. Those which act upon the tubules.

Naturally, one of the most efficient diuretics, through its action upon the blood, is water. If a man drinks a large quantity of water he is bound to pass a pretty large amount of urine. Sometimes the amount of water passed by a patient appears to be very greatly in excess of what he drinks. A patient of this sort was sent to me some time ago, and the doctor who had been attending him was much puzzled. The urine was certainly very watery, and the doctor found that, according to the statement of the patient and the patient's mother, the boy was drinking somewhere about 20 ounces of water per diem, and that he was passing over 100 ounces. I told the doctor that the thing was simply impossible, and that the boy was trying to cheat. The doctor at first was disinclined to adopt this view, but there was no other way out of it. It was quite impossible that the boy could manufacture 80 ounces of water in his body daily, and so the doctor began to examine more closely, and he found out that the boy was simply trying to cheat both his mother and the doctor.

In addition to water, certain salts are useful as diuretics, and more especially salts of potash. The salts that are generally used are the acetate, the citrate, and the nitrate. The nitrate, as we will presently find, has an action upon the circulation as well as upon the blood. Urea is a very powerful diuretic. We do not quite know how certain of our diuretics act, but there is no doubt clinically that small doses of calomel and a blue pill are occasionally very useful diuretics, and it is quite possible that they act indirectly upon the kidney through their affecting tissue change in the liver and producing substances which act as diuretics. Then we have a number of drugs which act upon the circulation, and you can readily see that you can increase the circulation of the kidney in two different ways. Firstly you can increase it by raising the pressure in the aorta as you can do experimentally by putting a ligature upon it or compressing it, or as you can do more easily, without any

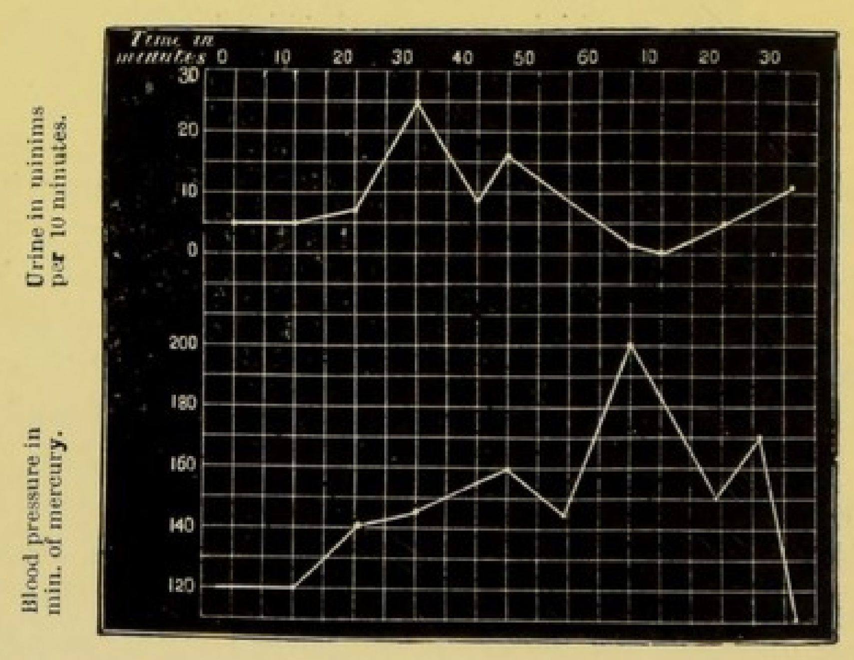

FIG. 136.—Curves showing the effect of erythrophlœum upon the blood pressure and secretion of urine. From "Phil. Trans.," vol. clxvii. At first both rise, but after a certain point, while the pressure continues to rise, the amount of urine secreted diminishes, and when the pressure reaches its maximum the secretion stops entirely.

operation, by giving a drug which will contract the arterioles in the body generally. Thus more blood will be driven into the kidney, and the pressure in the glomeruli will be higher. In consequence of this, nearly all the so-called vascular and cardiac tonics which raise the blood pressure are diuretics up to a certain point, but if you push any one of them too far its contracting action upon the capillaries or arterioles will be manifested not only in the limbs and intestines, but in the branches of the renal artery as well. It will cause the renal artery to contract until too little blood passes to the kidney to maintain the secretion of urine, and then the secretion of urine will be completely stopped exactly in the same way as if you had put a ligature around the renal artery. The renal artery, under ordinary circumstances, takes a great deal more blood to the kidney than the kidney requires to maintain the secretion of urine. If you put a clamp on the renal artery in a dog and tighten it gradually by a screw, no change takes place in the secretion of urine until you have got past the $\frac{1}{16}$th of the ordinary diameter of the renal artery. It is 27 years since I saw the experiment, but if I remember rightly the calibre of the renal artery may be reduced to $\frac{1}{16}$th before the secretion is much changed, and to about $\frac{1}{32}$nd before it is stopped.

Secondly, you can readily see that diuresis will likewise occur, if, instead of raising the general blood pressure and driving more blood into the kidney, you can dilate the renal arteries and induce more blood to flow into the kidney, while the general blood pressure remains much the same.

We increase the amount of blood going to the kidney either by driving more blood in under higher general arterial tension or by allowing more blood to flow in by dilating the vessels of the kidney, and so we get diuresis from two classes of drugs which have an entirely different action upon the circulation: we get diuresis from so-called cardiac and vascular tonics, which raise the blood pressure and drive the blood into the kidney; we get increased diuresis from vascular dilators, which lower the blood pressure generally, but dilate the vessels of the kidney, and allow more blood to flow in. Sometimes we get the best results in increasing the secretion of urine by combining those apparently entirely different classes of drugs. We may combine such a drug as digitalis, which contracts the vessels and drives more blood into the kidney, with such a drug as nitrate of potash or spirit of nitrous ether, both of which have the power of dilating vessels and by acting specially upon those of the kidney secure for it a larger amount of blood.

As I mentioned before, the class of cardiac tonics and vascular tonics is a very large one. We have belonging to it not only digitalis, but strophanthus, convallaria, adonis vernalis, erythrophlœum, and a whole lot of others, amongst which I must mention more especially sparteine, because this is a drug which acts very much like digitalis and is contained in a very common diuretic, viz., broom-tops. There is another, scillain, the active principle of squill, which has a similar action, and squill is very often given in combination with digitalis as a diuretic in dropsy. Indeed, one of the most favoured diuretics in dropsy is a combination of digitalis, squill, and blue pill. The mode of action of the blue pill here, as I have said, we cannot exactly tell, but both blue pill and calomel have got a peculiar power of increasing diuresis.

Amongst those which attract blood to the kidney are the nitrites which all have the power of dilating vessels, nitrite of ethyl, nitrite of methyl, nitrite of amyl, nitrite of butyl, and so on. Nitro-glycerine has a similar action. The organic nitrite which is chiefly used is nitrite of ethyl in the form of spirit of nitrous ether, and it is one of our most common and valued diuretics. The nitrates seem to have a similar power to the nitrites. They do not act so powerfully, but they act for a longer time, and so we find nitrate of potash, which modern researches have shown to have the double action of affecting the composition of the blood and of dilating the renal vessels, has long been known as one of the very best saline diuretics.

Then we have another class of diuretics which seem to affect the secreting structure of the kidney. There is one drug which probably has a powerful action in two ways, and that is caffeine. You know that caffeine in its chemical composition is nearly allied to uric acid and belongs to the same chemical family. Caffeine, like urea, has a powerful diuretic action, and probably tends to act first of all, as a cardio-vascular tonic, and, secondly, upon the composition of the blood and probably also to some extent upon the kidney itself. It is found that caffeine has the power of causing an increased secretion of solids as well as of water from the kidney, and it probably causes this both through its effect upon the blood-vessels and upon the tubules. It does not seem to cause any inflammation of the tubules. There are some drugs, however, which have an action upon the kidney corresponding to that of drastic cathartics upon the intestine. You will remember that a dose of croton oil given to an animal or a man causes great catharsis, and that if the animal be killed shortly afterwards the intestine is found to be very much congested. In small doses it produces diarrhœa, but in large doses it causes inflammation of the intestine.

Volatile Oils.—Now there are several drugs which have a similar action upon the kidney. They tend to cause increased secretion and diuresis in small doses, but in large doses they tend to cause inflammation of the kidney and complete stoppage of the secretion of urine. Amongst the most important of those are some of the volatile oils, and more especially oil of turpentine and the volatile oils closely associated with it, such as oil of juniper and oil of savine. Cantharides also has got a powerful stimulating action upon the kidney; it tends still more than oil of turpentine to cause inflammation of the kidney structure, with stoppage of the secretion of urine. It is frequently found that a combination of diuretics, like a combination of purgatives, acts better than any one alone, and we have in our Hospital Pharmacopœia one which, you will find, is very useful indeed in cases of dropsy, viz., the Haustus Scoparii Compositus.* You will readily see that if you wish to get a diuretic acting thoroughly well you had better mix together something to act upon the blood, something to act upon the circulation, and something to act upon the kidney structure itself. We have in the draught I have mentioned first of all the tartrate of potash, a saline diuretic, which alters the composition of the blood; next decoction of broom, which, as I have mentioned, contains spartein, which increases the flow of blood to the kidney; and last of all spirit of juniper, a drug which acts upon

* Potassii tartratis, gr. xx.
Spiritus juniperis, ♏xxx.
Decocti scoparii, ad ℥i.

the tubules of the kidney, and which in a large quantity would give rise to inflammation of the tubules, but which in a small quantity appears simply to stimulate them to action, and so, under the influence of these three, we get a large secretion of urine taking place from the kidney.

Uses of Diuretics.—We use diuretics for the purpose of removing water from the body in cases of dropsy. The dropsy may depend upon either disease of the heart or disease of the kidneys themselves. Where it depends upon disease of the heart, we frequently find that the dropsy tends to disappear as soon as we can get the heart into a proper state, so that mere rest in bed, by restoring the balance of the circulation and allowing the veins to become emptied and the arteries to become filled, will often tend to make the kidneys act without any drug whatever. In such cases the recovery of the patient is greatly quickened by the use of cardiac tonics, such as digitalis either alone or combined with a cardiac stimulant such as nux vomica.

In other cases we wish to remove not merely the water from the body, but solids also, as, for example, in fevers. We then frequently give abundance of water, quite contrary to the old notion of restricting water, and we often give the patients a drink which is exceedingly grateful to them, and which, at the same time, tends to remove from the body a number of the products of nitrogenous waste which might otherwise tend to accumulate. I do not know how many years ago it is that this draught was first used, but people had no idea then how it acted; they only knew that patients liked it, and felt the better for it. It was called the "Imperial" Drink—Potus Potassii Tartratis Acidæ. It contains acid tartrate of potash 60 grains, a sufficiency of sugar, and boiling water. Put one or two fresh lemons in this, and stir occasionally till cold; then strain and give it to the patient. Here you observe we have acid tartrate of potash, which acts as a refrigerant, increasing the secretion of saliva, and thus tending to lessen the feelings of heat in the patient, as well as to lessen the thirst. At the same time it acts as a diuretic, and clears out the waste products which are apt to accumulate in the tissues from the high temperature.

There are certain adjuncts to the action of diuretics. Supposing that you have a patient with an abdomen which is nearly filled with fluid, what will be the consequence? One can see from the tight, shiny skin of the abdomen that the pressure which distends it is great. But this pressure, being due to fluid or gas, does not act only on the abdominal walls. It tends to act equally in all directions, and to compress the abdominal contents as well as distend the parietes. More especially the ureters will be compressed, and their walls so squeezed together that fluid will flow through them with difficulty. This will cause backward pressure all through the tubules, and thus restrain the secretion of urine (Fig. 137). Moreover, there will be pressure, not merely upon the ureter, and thus indirectly upon the kidney, but the pressure will be exerted directly upon the kidney itself, and will tend to squeeze the blood out of it and prevent the entrance of arterial blood into it, so that the secretion of urine will be mechanically arrested (Fig. 138 C). In such cases you may give digitalis and tartrate

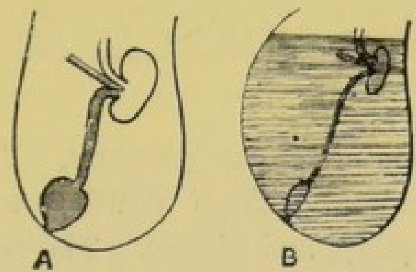

FIG. 137.—Diagrammatic section of the abdomen—A, in the normal state, B, in advanced dropsy, where the ascitic fluid compresses the kidney itself and also the ureter, so that the secretion of urine is hindered in two ways: (1) by pressure on the outside of the kidney and (2) by pressure on the inside of the kidney from the tension in the urinary tubules.

of potash, or nitrate of potassium and squill, or broom-tops until you are tired, because these things will not act in the face of mechanical pressure. In order to remove the mechanical pressure, you must first of all tap the abdomen and allow the fluid to run out, so as to lessen the pressure upon the ureter and kidney, and then you may expect your drugs to act. Even when we have no great pressure upon the tubules or upon the kidney itself, we may have backward pressure from the venous system (Fig. 138 B). Supposing that we were to tie a vein as it issued from the glomerulus, the consequence would be that this vein would gradually get larger and larger, press more and more upon the arterial capillaries, lessen the flow through them, and thus diminish the secretion of urine.

Thus we find that in cases of bad cardiac disease, and especially of mitral regurgitation or mitral obstruction, the urine becomes very scanty, high-coloured, and very often contains a considerable amount of albumin. Now in such cases it may be necessary to lessen the congestion in the kidney before you can get your diuretics to act. We, therefore, very frequently employ adjuvants, one of the best being free purgation from the intestine, which tends not only to remove fluid from the

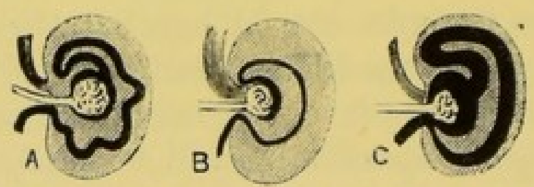

FIG. 138.—Diagram to show the effect of venous congestion and of obstruction of the ureter or tubules on the kidney.

A, normal kidney, with artery in the centre of the hilus. The artery ends in a glomerulus from which a urinary tubule passes into the ureter, which is shown passing out of the hilus below the artery. The renal vein is shown above the artery in the hilus. B shows congestion of the vein, with consequent compression of the artery and tubule; C shows obstruction of the ureter and tubules.

abdomen, but to lessen venous pressure. The drug most commonly used is compound jalap powder, which contains acid tartrate of potash, jalap, and ginger. The reason for this combination I have already given (p. 410) when discussing the action of purgatives. Sometimes in place of this you may use elaterium, in the dose of $\frac{1}{16}$th of a grain. Gamboge is sometimes employed, but very much less than jalap powder. You may occasionally lessen venous congestion in the kidney by altering the circulation by the application of a counter-irritant, such as a blister to the loins, or, still better, by dry cupping over the loins; but if the congestion be very great you frequently find good results by wet cupping over the loins.

Albuminuria.—In many cases we find that disease of the kidneys is accompanied by the presence of a large amount of albumin in the urine. We can often lessen this considerably by diminishing the amount of albuminous material that the patient is taking, and, as I told you before, in cases where the kidney structure is very much gone, you must adjust the amount of proteid material that the patient takes to the level of the kidney; but where there is a large amount of albumin passing out through the kidney you must not cut down the proteid material too much, lest you starve the patient, lest you allow more albumin to pass away than he can supply by his food. In many cases we find that limitation to a milk diet is very useful, the lactose in the milk tending to act of itself as a diuretic, washing the kidneys out and lessening the congestion that might otherwise be there. We find, however, that, as a consequence of albuminuria, we are very apt to get general degeneration of the blood, a form of anæmia. Nor is this to be wondered at, because we find in albuminuria that one of the constituents of the body, the albumin, is slowly draining away. To make up for this, we are likely to have increased destruction of blood corpuscles. We get, as a matter of fact, anæmia resulting from albuminuria. We find also in many of these cases that, if we give iron, not only does the destruction of blood cease, and the patients begin to be of a better colour, but, for some reason or other, the albumin in the urine becomes diminished. One of the favourite mixtures in cases of albuminuria is acetate of iron with acetate of ammonia. The acetate of iron is frequently given with acetate of ammonia or with acetate of potash, both these drugs going very well with it.

Lithæmia.—In cases where small quantities of water are passed, there is a tendency for the solids to be deposited whenever the water cools, so that sometimes a patient passes urine which, although it may be perfectly clear at the time it is passed, becomes very turbid indeed so soon as it gets cool in the chamber-pot, and then a thick deposit of urates frequently falls. But sometimes the deposit falls before it reaches the chamber-pot. It falls either in the kidney itself or in the bladder, giving rise to renal or vesical calculus.

It is to be borne in mind that the most universal solvent in the world is water.

There are other things more powerful on certain occasions; nitric acid, for example, will dissolve copper or silver in a way that water will not, but there are many things that nitric acid will not touch and water will. So that, in cases where you wish to get solution of a calculus or to prevent the deposition of a calculus either in the kidney or in the bladder, it is advisable to tell your patient to take a large amount of water. The water may be either hot or cold. Cold water is pleasanter in summer, but in winter and spring a large quantity of cold water is apt to lie heavy at the stomach, whereas, if you give it to the patient as hot as he can comfortably drink it, it is quickly absorbed and quickly excreted. Thus it tends to prevent the deposition of any solids in the urinary passages, or to dissolve any that may have been already deposited.

Direct and Indirect Alkalies.—In cases where the deposit tends to be of an acid nature, it is sometimes advisable to give with the water some alkaline substance. We have two divisions of "Alkalies"—a class of drugs which render the urine alkaline. Some of these are called direct, and others indirect, alkaline remedies. The direct ones are those which have a direct action both upon the gastric juice and upon the urine. As a good example we may take carbonate or bicarbonate of soda or of potash, which neutralise the gastric juice, and render the urine alkaline also. The indirect are those which have no neutralising action upon the juices of the stomach, but render the urine alkaline, and as an example of these we may take the citrates, acetates, or tartrates of potash, soda, or lithia. Although these are neutral salts, they undergo a change in the body, and become alkaline. Citric, tartaric, or acetic acids, when combined with a base such as potash or soda, become burnt up in the body, most probably in the muscles. Thus the neutral salt is converted into a carbonate, which, as you know, is an alkaline salt, and it passes out as a carbonate in the urine, rendering it neutral or alkaline. Sometimes alkaline bodies tend either to render the urine less irritating, or the bladder less susceptible to irritation. About the middle of last century a certain Mrs. Joanna Stephens possessed a secret remedy for stone, which was so celebrated, and was reckoned so valuable, that the British Parliament purchased it in 1739, for the public benefit, from the old woman for £5,000. When they had got the secret, this valuable remedy was found to consist of calcined egg-shells, soap, and some aromatic bitters, so that its essential ingredients were neither more nor less than a little carbonate of lime with a little phosphate. In cases, therefore, of irritable bladder, where there is a stone suspected, along with a tendency to uric acid deposit, the administration of some lime-water or carbonate of lime may be useful along with carbonate of potash or soda. Although I have not yet definite experiments to bring forward in proof of my supposition, yet I suppose the reason of this to be that the lime in the process of excretion has a sedative action upon the bladder similar to that which it exerts on the intestine in cases of diarrhœa.

Hydrotherapy of Lithæmia.—There are certain waters which in one way or another are exceedingly useful in causing the stones to be passed either from the kidneys or from the bladder. There are two springs especially, one in France and one in Germany, to which it is the custom to send patients suffering from calculus in the kidney. The one is Contrexéville, and the other is Wildungen. Contrexéville is simply the centre of a large group of watering-places. Quite close is another one, Vittel, which, though it may be as good as Contrexéville and cheaper to live in, is a very slow place, and a little further off is a still slower place, called Martigny-les-Bains. Contrexéville contains chiefly an alkaline water, but there is a little iron present in the water both here and at Wildungen. The proportion of iron is very small, and I asked one of the doctors at Wildungen what action he supposed the iron would have. He said that, although he could not prove it, he thought that in cases where there was a stone in the kidney the iron tended to act as an astringent upon the walls of the ureter, and lessened any inflammatory or irritative thickening that had taken place in them, so that the stone slipped more easily into the ureter and passed more easily through it. Whether this be so or not, there is no doubt about the fact that both at Wildungen and Contrexéville patients pass stones to an enormous extent. I am always afraid of quoting the number of stones passed by one patient whom I sent to Contrexéville. I said one day it was 80, but in looking up my notes I found it was over 100 in less than three weeks. They were naturally small, but still the number was very great. He seemed to have simply cleared out the pelvis of his kidney, and he remained perfectly well for two or three years afterwards. Then, having another slight attack, he went back to Contrexéville. There are certain drugs that are supposed to dissolve stones, but I doubt very much if there is anything that will dissolve them excepting distilled water or salutaris water, which is one of the best things you can make the patients drink, but what you have to attend to chiefly is that they drink a large quantity rather than any particular kind of water.

LECTURE 29.

Lithæmia, *continued*—Treatment—Phosphaturia—Drugs rendering urine acid—Effect of diet—Action of drugs on the bladder—Paresis of bladder—Effect of suggestion—Hysterical retention—Increased frequency of micturition—Causes—Increased acidity—Vesical catarrh—Treatment—Incontinence—Treatment—Action of cantharides and belladonna—Action of drugs on the urethra—Action of drugs on genital organs—Seminal emissions—Nymphomania and satyriasis.

GENTLEMEN,

In cases of renal calculus, where you are unable to persuade the patients to go to either of the places I have mentioned, you may gain very good results by allowing them to drink the Contrexéville or Wildungen waters at home, although this plan is not quite so successful. In addition to excessive concentration, there are two conditions of the urine which tend to bring on the formation of stone, viz., (1) excessive acidity and (2) alkalinity. The most important of all is a concentrated condition of the urine with very little water compared with the solids, and, as I mentioned before, one of the best remedies for removing a tendency to calculus is hot water. But in certain cases you find that the urine is excessively acid, and that there is a tendency to the formation not of urates, but of free uric acid, which is much less soluble in water than urates are. You can readily convince yourself of this fact by taking some urine containing uric acid, or even containing such acid urates as are usually deposited. Add to this a little liquor potassæ, and you will find that the urine will clear up, the neutral urates being much more soluble than either the uric acid or the acid urates. You can see this taking place in a test-tube, and to some extent you can imitate it in the living body. When you get a patient who is passing a quantity of water containing a thick sediment, you can generally clear it up by administering to the patient some alkali, and, as I mentioned before, you can give either direct or indirect alkalies. The direct alkalies, such as liquor potassæ or the carbonates or bicarbonates of potash, soda, or lithia, will neutralise any acid in the stomach as well as in the urine, while citrates, acetates, or tartrates, which are indirect alkalies, will not have any effect upon the gastric juice, but will undergo combustion in the organism and be passed out as carbonates, rendering the urine alkaline. In this way you aid the solvent action of the water, and you prevent the deposition of calculi, especially those consisting of uric acid.

Phosphaturia.—But there is another condition in which you tend also to get deposition of calculi of another kind, and that is when the urine has a neutral or even alkaline reaction, for these phosphates become insoluble and are deposited as a whitish sediment. Sometimes the acidity of the urine is so slight that the deposition of phosphates takes place even in the bladder, and many patients come to the doctor complaining of this condition, and say that there is something very far wrong with them, because they are passing water which looks like milk, not after standing only, as urine containing urates often does, but it has this appearance, and is quite turbid and thick, at the moment that it is passed. Now many people believe that this deposition of phosphates depends upon the presence of an increased quantity of phosphates in the urine. This is not the case at all. In many such instances the amount of phosphates is actually less than normal, but they are deposited because the acidity of the urine is less than normal, so that the phosphates are no longer kept in solution. Here again you can dissolve these phosphates in a test-tube by simply adding a drop or two of acid, but it is not so easy to imitate this process in the living body. It is perfectly easy to render an acid urine alkaline, but it is by no means easy to render an alkaline urine acid. Frequently this condition is more or less of a normal process. In very many people during the process of digestion so much acid goes into the stomach to dissolve the food that the corresponding amount of alkali which goes back into the blood increases its alkalinity so much that the urine which is secreted from it becomes alkaline (Fig. 139). This phase has been termed the "alkaline tide." You will frequently find the urine passed by healthy people a couple of hours after a meal quite neutral or even alkaline, and during digestion there is very apt to be a deposit of phosphates in the urine.

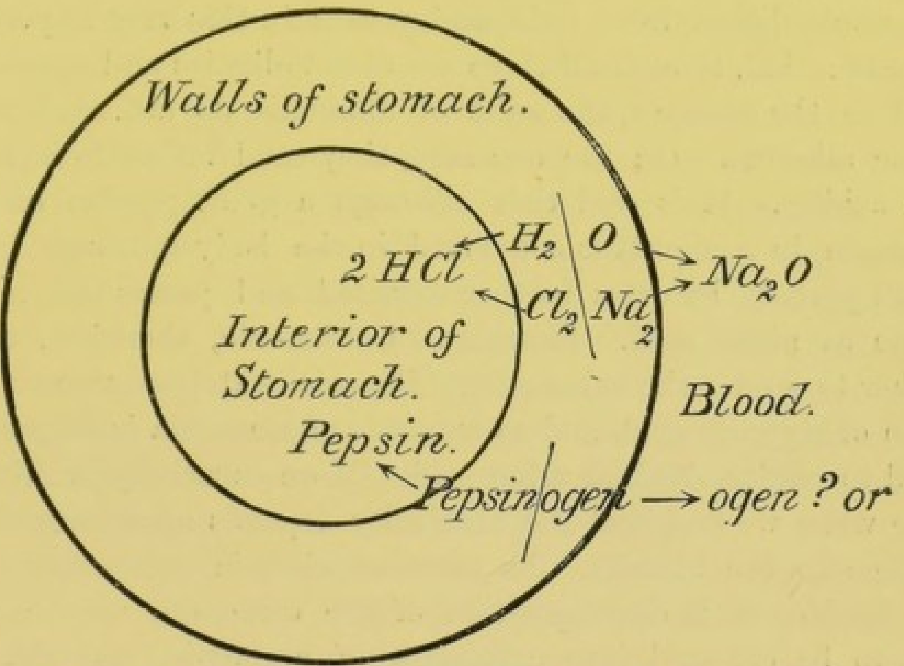

FIG. 139.—Diagram to illustrate the chemical change during secretion.

You can easily see that, if the acid which has been poured out into the stomach during digestion is not readily re-absorbed, you are likely to get a more or less persistent condition of phosphaturia, and if the urine is not simply alkaline during digestion, but remains persistently so, then you look to the stomach to see if it is all right, and very frequently you find that it is dilated. If you can bring about a healthy condition of the stomach, you are likely to bring about a healthy condition of the urine. Very often attempts are made to remedy phosphaturia by the administration of mineral acids, but, as I have said before, it is by no means easy to render an alkaline urine acid. The difficulty is that, if you try to give mineral acids in sufficient quantity to make the urine acid, you are apt to damage the stomach in your attempts. One of the commonest mineral acids that is given for this purpose is phosphoric acid, because it may be given in larger quantities than nitric or hydrochloric acid, without having any injurious action upon the stomach itself. The dose of phosphoric acid is generally 20 minims freely diluted either immediately after food or between meals. Another drug that is frequently employed, however, is benzoate of ammonia. Ammonia differs from soda and potash in this very important respect: that, though all three are direct alkalies and neutralise acid in the stomach, the salts of ammonia do not render the urine alkaline. On the contrary, they tend rather to increase the acidity. It is said that although a great portion of the nitrogen in ammonia is converted in the body into urea, yet a small portion becomes further oxidised and passes out in the urine as nitric acid. Benzoate of ammonia, therefore, tends rather to render the urine acid. Benzoic acid passes out in the form of hippuric acid, and so benzoate of ammonia is frequently used to render alkaline urine acid. More especially is this the case when we find that the alkalinity depends upon some local change in the bladder. In cases of chronic inflammation of the bladder with decomposition of the urine, the urea is very apt to be changed into carbonate of ammonia, and thus to render the urine alkaline, and in such cases the administration of benzoate of ammonia by the mouth is often employed, because the hippuric acid probably has a slight antiseptic action and is therefore useful.

A chronic condition of phosphaturia frequently occurs in persons who are debilitated. You can readily see that if the body generally is weak the re-absorptive powers of the stomach and intestine will also be weak, and so the acid, which is formed and poured into the stomach during the process of digestion, will remain in it and will not be re-absorbed Consequently you may find that simple exercise without fatigue will greatly help people who suffer from chronic phosphaturia. It is a condition that is by no means uncommon amongst students, because very often during a great part of the day they are sitting in lecture-rooms, or attending in the operating theatre, or working in the anatomical rooms, and thus they get very little exercise. Frequently you will find that many of them pass in the middle of the morning, about two hours after breakfast, a urine which is almost like milk when voided, and yet those same men are suffering from no disease whatever, and when they get a little more exercise they are all right. The same thing is often observed in young men who are confined in merchants' offices, or bank clerks, or those engaged in any such sedentary occupation; so that a condition which may be termed an exaggerated normal phosphaturia is very common indeed. It gives rise to a great deal of unnecessary mental discomfort, and very often leads men to believe that they are suffering from a serious disease when there is no real disease whatever. A little exercise in the open air will generally put a stop to the trouble, but if the person so suffering is unable to take open-air exercise vigorous exercise at home with light dumb-bells or light Indian clubs will probably answer the purpose. The exercise, however, should not be carried to such an extent as to fatigue the patient, because fatigue tends to increase the general weakness and thus to make the condition worse.

Effect of Diet.—You may also do a good deal to remedy this condition by means of diet. I daresay many of you have noticed that a horse's urine is almost invariably turbid when passed, whereas a dog's urine is almost invariably clear, and yet the dog's urine contains probably a very much larger proportion of solids than the horse's. But then the dog's urine is excessively acid, so that when passed warm it leaves no deposit; whereas the urine of the horse is generally alkaline, and so the urine is turbid from phosphates. This difference in the urine depends in great measure on the difference of food, and not merely on the difference of animal, the horse being herbivorous and the dog being to a great extent omnivorous. I say "to a great extent," because dogs generally get a certain amount of meat, although they are often fed partially upon farinaceous food. From a farinaceous and plant diet you get a larger quantity of phosphates and a less amount of acid, and so a person who is suffering much from phosphaturia should be induced to diminish the amount of vegetable and to increase the amount of animal food. On the other hand, if the patient is suffering from excessive acidity of the urine it is necessary to limit the animal food and increase the amount of vegetable food.

We often find that this exerts a most beneficial influence upon the secretion of urine, and thus tends to prevent the deposition of gravel or calculi in our patients.

Action of Drugs on the Bladder.—The bladder, which serves as a receptacle for the urine, deviates from the normal mainly in two directions, viz., (1) paralysis and (2) increased irritability. We sometimes find that patients have difficulty in passing water. This may be due to paralysis from over-distension. If you blow up an indiarubber ball you all know that after you have distended it beyond a certain point it loses its power of contraction, and the same thing occurs with the bladder as well as with another important viscus: the stomach. When either is distended too much it tends to lose its power of contracting, and to remain more or less permanently dilated. In such a case as this it is generally requisite to remove the urine by means of a catheter. But occasionally, even in apparent health, a man may lose his power of passing water, and this loss of power is of nervous origin, and frequently occurs in nervous people. I think it was Sir James Paget who very aptly applied to the condition the term of "stammering bladder;" just as a stammering tongue is unable to get out the words, so the stammering bladder is unable to extrude the urine. Curiously enough, one is often able to help this condition very easily. Suggestion has a great power of acting upon the bladder, and many men who can pass urine perfectly well if they are left to themselves cannot do so in the presence of others. If they are hurried, they very often fail to pass urine, and so it not unfrequently occurs that men whose bladders have become distended during a railway journey jump out at a station and try to pass water, but try in vain; so that they have to jump in again without being able to empty their bladders at all. Now, if you are engaged in life assurance work, you will find the same thing happening. The proposers come to you and wish to insure their lives. It is often of great importance that you should get a specimen of the urine at the time, because without having the urine you cannot complete your report upon the patient's life. In such cases, and in all others where there is a difficulty in passing water, it is useful to remember that there is a plan which has the same effect upon man that whistling has upon horses. You know that grooms constantly whistle to horses when they want them to pass water, and if you make a noise somewhat similar to that produced by the water as it falls from a man's penis into a urinal, you may get him to pass water. This plan is more than a century old. It was adopted by the famous Dutch physician Boerhaave. It was before the days of taps, and he used to have a screen in his consulting room, and behind this was a tall footman with a jug of water and a basin, who was instructed when the patient could not pass water just to allow the water to drip into the basin. If you can continue to make this sound in a patient's ears, leaving him all the time to himself, he will generally be enabled to pass water; and it is a great blessing to many a railway traveller that the railway companies have in many stations put up perforated pipes, the running water from which not only flushes the urinals, but helps the hurried traveller to urinate. You must remember also what I have just mentioned, and leave the patient to himself, because if you stand beside him while the water is flowing very likely he will not be able to urinate, but if you leave him to his own devices, and allow the sound of the running water to fall upon his ears, he will do so without difficulty. There are some patients in whom the mere idea of the sound of a waterfall tends to bring on the evacuation of urine, and the application of cold water to the hands has a similar effect; so that in lavatories men usually pass water before they wash their hands, both for the sake of cleanliness and because if they were to wash their hands while the bladder was full the mere feeling of the cold water upon the hands would bring on the desire to evacuate the bladder in the middle of the operation of washing their hands. In cases where these means are insufficient, you sometimes are able to attain the object you wish and get the bladder evacuated by applying a hot sponge over the perinæum in men or over the vulva in women. Sometimes in place of the hot sponge a hot hip-bath is even more efficacious, and when these means fail you have, as a rule, recourse to the mechanical removal of the urine. But there are many cases in which you wish to avoid the mechanical removal of urine by every means in your power. For example, in cases of hysterical retention of urine you wish to do your very best to avoid introducing a catheter; and in cases of enlarged prostate it is a great boon to the patient if you can enable him to micturate without the use of a catheter.

Another condition which is just as troublesome as retention is diminished power to retain. Some patients suffer from irritability of the bladder, and in others we find absolute incontinence. Irritability of the bladder may depend (1) upon a condition of the nervous system, or (2) upon the composition of the urine, or (3) upon the condition of the bladder itself and the nerves which are contained in it. There are many people who suffer from a tendency to irritable bladder under precisely those circumstances where they know they cannot make water. So long as they know they can evacuate urine at any moment they are all right, but the moment they are shut up in a carriage, church, or theatre, and know that they cannot do so, the desire comes on at once. In such cases it is evident that the desire is purely a nervous one, and men can train themselves out of it by resisting the desire. There is no real definite substratum for the disease; it is not necessary for them to evacuate the bladder, and if they simply resist the desire several times it tends to pass away, and they get back into the normal condition.

Increased Acidity.—In patients where there is an actual alteration in the condition of the urine or bladder this is not the case. Generally the condition of urine that brings on this increased desire is excessive acidity, or the presence of a large proportion of salts in the urine. Excessive acidity is a very common cause, and this may be counteracted by alkalies, either direct or indirect, such as I have already mentioned. In cases where a large proportion of salts is present this is easy to remedy by allowing the patient to drink more water; and although at first you would imagine that taking water would be likely to increase the frequency of micturition, it is not always so. A gouty patient comes to you and complains of a tendency to pass water very frequently, and you tell him to drink Vichy water in larger quantities than he has been accustomed to take. Although you thereby increase the amount of water that he actually passes per diem, you lessen the number of calls to micturition, for the urine becomes less irritating to the bladder, and consequently the patient is able to hold a larger quantity of water at a time, and does not micturate so frequently. There is another point I should mention in cases of gout. You may find that the calls are very frequent, and even that the use of alkalies does not seem to lessen them to the extent you desire, but in some of those cases you may find that anti-gout remedies, such as piperazine, will tend to lessen this irritability of the bladder, and I have known it succeed when other things have failed. You may, of course, try also such substances as salicylate of soda, especially when combined with sedatives which act upon the bladder, such as belladonna.

Vesical Catarrh.—Now another condition in which we find irritability of the bladder is catarrh of the bladder, where there is inflammation of the mucous membrane; and here we try to do two things: we try to restore the mucous membrane of the bladder to a healthy condition, and we try to lessen the irritability of the nerves in the bladder itself. We restore the healthy condition of the mucous membrane by piperazine, which will tend to remedy a gouty condition of the system, and by such drugs as benzoate of soda or of ammonia, which will tend to render the reaction of the urine more natural. We give also astringents of various sorts, such as pareira, buchu, and uva ursi, and many others containing a certain amount of tannin. Substances having an antiseptic action are frequently useful, such as carbolic acid in small quantities, salicylic acid, or salicylate of soda and salol. Salol is an exceedingly useful substance, because it is split up, as I have told you before, in the intestine into salicylic acid and phenol, both of which are useful antiseptics. In cases of catarrh or of acute inflammation also we lessen the irritating qualities of the urine by diluting it by administering either hot water, or, what is more often used in its place, barley-water, or linseed tea. In cases of inflammation of the bladder linseed tea is a very favourite remedy. I really do not know whether linseed tea has any more sedative action upon the bladder than plain water has. It is usually imagined that the mucilaginous part of the linseed is absorbed, that it passes out in the urine, and that it has a similar soothing action upon the bladder and upon the urethra to that which it has upon the throat. This is highly doubtful, but, notwithstanding, the practice of using linseed tea is a common one, and it really seems to answer as well as anything else, so, perhaps, there may be some reason for its general adoption.

Incontinence.—Another very troublesome condition is incontinence of urine, inability to hold water. This is by no means unfrequent in children. They often hold water well enough during the day, but when they are put to bed at night the bladder evacuates itself, the bed is wet, and there is a great deal of discomfort both to the child and everybody concerned, and naturally mothers are very anxious to stop this. Now there are various means for trying to stop the condition, and you may find it necessary to use every one of them that you know, because occasionally incontinence of urine is a thing that is very troublesome indeed to treat, and may continue in spite of all your efforts. First of all you try to get the bladder empty and keep it empty. The mother must make the child pass water before it is put to bed; it should then be awakened about an hour afterwards and made to pass water again. It has been supposed by some that incontinence of urine is really a form of epilepsy. It takes place generally during the first hours of sleep, and if you get the child past midnight without having evacuated its bladder, it will probably be all right till morning. You may give bromide of potassium as a remedy to the child, and you sometimes get benefit from it, but the drugs that seem to be most useful are belladonna and cantharides. Now those two drugs possess an entirely opposite action: belladonna tends to act as a sedative to the bladder, lessening its irritability; cantharides acts as a stimulant to the bladder, greatly increasing its excitability. Here again it would seem as if it were perfect nonsense to attempt to treat a condition by two entirely opposite remedies, and yet practice shows that they both are successful in many cases. Now the explanation of that is, we have two different organs to deal with, or parts of organs. At the neck of the bladder, where it opens into the urethra, there is a sphincter, and in the fundus of the bladder itself there are a number of involuntary muscular fibres (Fig. 140), the

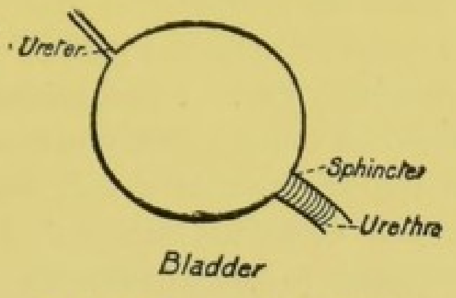

FIG. 140.—Diagram of the Bladder.

contraction of which tends to expel the urine. They can hardly expel the urine if the sphincter is contracted, but when the sphincter relaxes, the urine will almost run out without any exertion on the part of the bladder, the mere pressure of the abdominal walls tending to press it out. But when the sphincter is contracted, the fundus of the bladder may contract as much as ever it can and yet not a drop of urine will pass. Now you can see that if the sphincter is insufficiently stimulated, it will remain more or less lax and will allow the urine to run out, but if you can stimulate it it will contract, and then you will stop the incontinence.

Cantharides has apparently the effect of stimulating the whole bladder—both the fundus and the sphincter—and so, although if cantharides acted only upon the fundus, it would tend to cause increased expulsion of the urine, yet by stimulating the sphincter it tends to cause retention, and thus, by giving it to a child that is suffering from incontinence, you may find that you cure the condition. On the other hand, you can see that if the fundus is contracting too strongly while the sphincter does not contract proportionally, you will have the urine expelled, and if you can give a drug which will lessen the irritability of the fundus without lessening too much the excitability of the sphincter, you will again relieve the condition, and this is apparently what belladonna does. It lessens the irritability of the bladder, so that there is less expulsive tendency, and by using this drug or cantharides incontinence of urine is very often cured. You must, however, note that if you are using belladonna you must push it until the patient shows symptoms of poisoning. You may cure your patient before you do this, but you must be prepared to give the drug until the condition is either cured or until the patient's pupils are dilated and the mouth excessively dry. I well remember the case of a lady who had suffered for many years from incontinence of urine. Her husband was the Director of a very large and important hospital, and she had consulted many doctors. I asked her husband when she came to me whether she had been poisoned with belladonna. He said "No, she has never been poisoned," so I said that we must push the drug until she was either cured or symptoms of poisoning appeared. It was not necessary in her case to bring on the symptoms of poisoning, for although we gave her much more belladonna than she had ever had before, the disease was cured before they appeared. The failure in her case on previous occasions was simply due to the drug not having been pushed far enough.

Action of Drugs on the Urethra.—We find that in the urethra there are various abnormal conditions, especially those of irritation and of inflammation. In most cases of inflammation of the urethra there are organisms present, the gonococcus being the most frequent. In order to cure the inflammation we have first of all, if possible, to destroy the infective organism, and this is done either by medicines given generally or given locally. Two of the most common drugs which are usually given for this purpose are copaiba and cubebs. Sandal-wood oil is another drug that is very frequently employed. All these contain volatile oils, and some also resins, and both the volatile oils and the resins appear to have an antiseptic action. They are excreted in the urine, and the consequence of their administration is that the urine from the kidney downwards to the meatus becomes aseptic. The germs become destroyed by the products of the volatile oils as they pass out. Local antiseptics may also be used, such as solutions of carbolic acid, weak solu tions of permanganate of potash, solutions of boric acid, and so on. Besides this we wish to exercise also an astringent and sedative action upon the inflamed, irritable, and thickened mucous membrane, and this is generally done by means of astringent injections, one of the most common containing a mixture of opium and lead. Another very useful one contains a mixture of acetate of lead and sulphate of zinc. We have in our Hospital Pharmacopœia several of these injections.* An old-fashioned one, which is exceedingly useful, contains a mixture of acetate of lead and sulphate of zinc, and this seems to be an entirely unchemical and unreasonable composition, because a double decomposition takes place between the ingredients, and sulphate of lead is thrown down in a thick, white, smeary mass; but in reality this is not at all an objection to it, as the solution of acetate of zinc which is formed is a very powerful astringent, and the sulphate of lead which is precipitated appears to have a local sedative action, the fine powder, or rather paste, tending to keep the sides of the inflamed urethra apart from one another. This has been imitated by the use of China clay or kaolin, the action of the sulphate of lead or kaolin on the urethra being precisely the same as that of the powder which is used in dusting babies to keep the folds of skin apart from one another and thus prevent irritation. In our Hospital Pharmacopœia we have the compound zinc lotion containing a grain of sulphate of zinc, one of acetate of zinc, ten minims of tincture of catechu, and liquid

* Lotio Calaminæ Co.
Calaminæ Preparatæ, ʒii.
Zinçi oxidi, ʒii.
Liq. plumbi subacetatis, ʒi.
Glycerini, ʒi.
Aq. calcis, ad ℥i.
Lotio Zinci Co.
Zinci sulph. gr. i.
Zinci acetatis, gr. i.
Tinct. catechu, ♏x.
Extr. opii liquid, ♏xxx.
Aq. destillatæ, ad ℥i
Lotio Zinci sulphocarbolatis.
Zinci sulphocarbolatis, gr. iv.
Aq. destillatæ, ad ℥i.

extract of opium. Here we have the action of the zinc and catechu as astringents and the extract of opium in lessening irritability.

Action of Drugs on the Genital Organs.—We may pass on now from the urethra to the genital organs in general, and we have first to take up the effect of drugs which lessen the sexual desire. The centre for the sexual organs is situated in the lumbar portion of the spinal cord (Fig. 141), and it may be

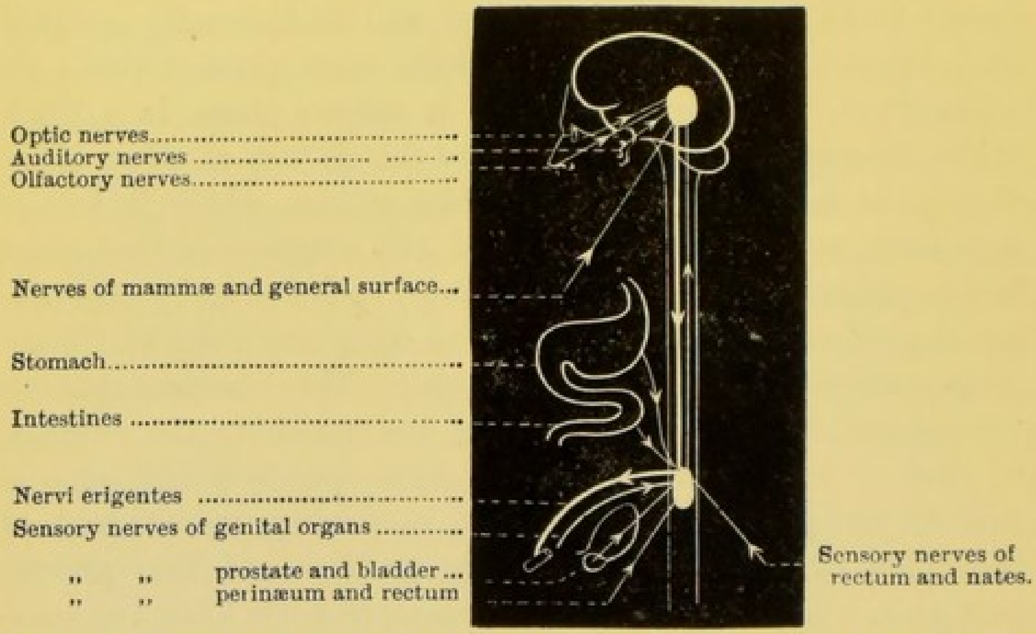

Fig. 141.—Diagram to illustrate the effects on the genital centres of irritation of the stomach or intestine by flatulence, acrid matters, or fæcal accumulations. It also shows the nerves through which the cerebral and spinal genital centres may be stimulated.

excited either from the brain or reflexly by the genital organs, or from other parts. Frequently the sexual desire becomes abnormally strong, too strong indeed for the conditions under which the patients are placed; so that it becomes disagreeable, and may even be dangerous, leading them into habits that may be very injurious. Now, in order to lessen the sexual desire, we may lessen those things that are likely to excite it by lessening the irritants. We may lessen those that pass from the brain. For example, the desire may be excited by various thoughts, by books, by pictures, and so on. We lessen these stimuli by the avoidance of all such things, and we try to drive away these ideas by directing the brain to other things. We may lessen also the sexual desire by taking care that there shall be no irritant applied to the genital organs. Occasionally an unsuspected irritant may be the presence under the prepuce of smegma that has become partially decomposed, and yields irritating organic acids. This may simply act as an irritant by itself, or it may bring on a condition of irritability in the mucous membrane which may persist after the irritation has been removed. If a condition of eczema be present it becomes still worse, because eczema is frequently associated with intense irritation and a desire to scratch or rub which is almost irresistible; and I believe that many cases which have been put down in history to unconquerable and extraordinary viciousness are simply due to eczema. In one's schooldays one used to read of Messalina and Agrippina, and of other Roman Empresses whose behaviour was simply scandalous. Now in the case of Agrippina, who used to leave the Palace of the Cæsars and go to the brothels of Rome and stay there all night, having coitus with anyone who cared to come, it is obvious that the condition was not one of health, it was one of disease, and it is by no means improbable that both she and Messalina suffered from eczema of the vagina; and if they had been treated by vaginal douches of lead and opium they might possibly have remained respectable members of society, instead of being held up for the opprobrium of the world throughout all ages. This is a condition that patients will not often mention. It is only now and again that you may learn that such a condition does exist, and that the irritation in the vagina is so great as to bring on a desire either to have coitus or to rub the part, which is irresistible, and drives the poor woman nearly mad. In some cases I believe it does drive them mad, and that there are cases of suicide which are simply due to this condition. It is one, therefore, that you have always to keep your eyes open to, and in such cases you must treat the condition as you would treat eczema in any other part of the body, by soothing lotions or by soothing ointments. At the same time, you must bear in mind that eczema, wherever it be situated, is to be treated not merely locally, but generally. If it comes on in a gouty patient, you have to treat the gouty condition generally by baths, mineral waters, alkalies, and other anti-gout remedies, telling the patients at the same time to be careful of their diet, because in many of those cases you may find that the irritation is increased by various articles of food. For example, a large amount of meat will frequently increase it, whereas if the patient be put upon an almost vegetarian diet it will decrease. Certain articles even of vegetarian diet do not suit, such as sugars and certain fruits, and the patient must find out for himself or herself what articles of diet seem to disagree, and to bring on this condition of excessive irritability. In certain warm countries, to avoid the local irritation that would be caused by the accumulation of smegma, the practice of circumcision has been adopted; and even in circumcised persons it has been found that, unless careful attention be given to washing the penis, that much irritation may occur; so that in Mohammedan countries men are obliged to wash the penis with water if they can get it, and with sand if they cannot. Another source of irritation may be not from the outside, but from the inside of the penis, because irritation in the mucous membrane of the urethra also tends to excite the sexual desires reflexly; and so if the urine be excessively acid it tends to excite these desires, and they may then be lessened by diminishing the acidity of the urine by alkalies. It has been stated also that certain salts, such as nitrate of potash and chlorate of potash, cause such irritation of the mucous membrane as to lead to the desire to rub the parts and to induce boys to masturbate. One must, therefore, be careful to avoid large doses of chlorate of potash or nitrate of potash, especially with too small a quantity of water, because if these salts be freely diluted they are not likely to cause any such irritation, and so they are not likely to lead to any bad results. I think I have already mentioned that chlorate of potash in large doses has the power also of disintegrating the blood, and leading to hæmatinuria, the broken up corpuscles passing out in the urine. When the drug has been pushed to this extent the condition of the patient is a very dangerous one, for it shows that the drug has been given to such an extent that recovery from its effect is very likely not to take place.

Other sources of irritation may be present in the stomach or in the intestines. Before passing to the stomach and intestines, I ought to mention also that another condition of irritability may occur outside the scrotum from eczema occurring there, and that in such cases it is well to treat the patient by putting on something that will keep the surfaces of the skin apart. This is a condition that leads to a great deal of discomfort in patients, because the irritation from the eczema is such that he cannot sleep. The easiest way of treatment is just to keep the scrotum and penis apart by means of a piece of lint about 2 or 2½ feet long and 4 to 6 inches

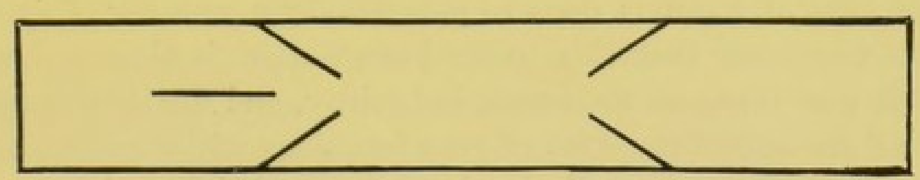

FIG. 142.

broad, of the shape which I show you, and which is put between the legs. The penis and testicles are introduced through the hole and then the lint is fastened to a broad piece of tape or something to go round the middle, and in this way you get the penis and testicles on the one side of the lint and the skin of the thighs on the other, so that the skin of the scrotum does not come into contact with the skin of the thighs. In many instances you are able to give great relief to your patients' sufferings. When there is great irritation you can, with advantage, apply to the parts either a dusting powder, such as Fuller's earth, oxide of zinc, or carbonate of zinc, or an ointment such as ointment of zinc.

You are very likely to be asked by patients in regard to seminal emissions. Now these, as you know, but many of your patients do not know, are a normal condition. The rectum usually is evacuated once a day, the bladder is usually evacuated three or four times a day, and the seminal vesicles into which the testicles are constantly secreting semen, as they do in young men, require to be evacuated every now and again. The evacuation usually takes place once or twice a month.

There is in man, just as there is in woman, a regular rhythm, and men generally have a monthly period just as women have, but very frequently in man the period comes not once a month but twice a month. Now at their period men have an evacuation from the genital passages just as women have, and this usually takes the form of an evacuation of semen during the night. The seminal vesicles, as you know, are lobulated and there are two of them, so that occasionally both vesicles may be completely evacuated at once in a large evacuation, or one vesicle may evacuate itself one night and another the next night, or you may have several small evacuations, each of the lobules having evacuated themselves at different times. Now a great deal of harm is done to patients by a number of quack books which say that this natural evacuation is abnormal, and that it will bring on weakness, imbecility, and finally dementia and all the rest of it. One of your functions will therefore be to tell your patients that all this is perfect rubbish, and you may do them a great deal of good by simply easing their minds. At the same time there is a spermatorrhœa just as there is a diarrhœa, and the seminal vesicles may evacuate themselves too often. Now there is also a condition which gives rise to a great deal of panic on the part of many patients, and that is that during defæcation some semen or prostatic fluid passes out from the urethra. It would be a wonder almost if that were not so, because, as you know, the seminal vesicles lie right in front of the rectum, and if a hard scybalous mass is passing through the rectum it is very likely that some of the fluid contained in the vesicles will be forced out by the mere mechanical pressure. Here again what you want to do is to keep the patient's mind easy, and to keep the bowels open so as not to allow the pressure of the hardened mass to come upon the seminal vesicles.

Just as the prostatic fluid may be pressed out mechanically, so we may have irritation of the sexual organs reflexly from the intestine, and this may occur from the presence of ascarides in the rectum or from the presence of eczema or pruritus round the anus, or from the presence of piles. Moreover, we may find that the mere distension of the intestine by flatus may bring on evacuation of semen, or may bring on erections. Erections occur during the night either with or without evacuation, and may sometimes be treated by the very simple plan of giving the patient at night before he goes to bed some bicarbonate of soda, with perhaps some gentian, rhubarb, and a little nux vomica. The nux vomica appears to be useful here, and yet it is one of the drugs that you require to be careful of in treating cases where there is any sexual irritability, because *per se* it tends to increase the sexual excitability. It is a powerful aphrodisiac, and sometimes you find that its exciting action upon the sexual organs prevents you from using nux vomica, or strychnine, as a general tonic. You give your patients strychnine, or nux vomica, and expect them to come back and tell you they are feeling stronger and better; but, on the contrary, they come back and tell you they are feeling miserably ill. Then if you make inquiries you find that it has excited their sexual passions, and the consequence has been that they have had spermatorrhœa, and they are feeling very much worse than before. Yet when given at night it may be very useful in checking erection, but its action then is not upon the genital organs; its action is in tending to prevent distension of the intestines by gas. By keeping the bowels free from irritation by fæcal matters or distension by gaseous products we may reduce the chance of irritation of the genital organs during the night. Besides this, we may lessen the excitability of the nervous centres generally to stimuli, and this may be done by directing their forces in other ways. Many of you know that the athletes of ancient Greece during the period of their training for the Olympian games were nearly impotent; that both sexual desire and sexual capabilities appeared to have gone during all the time they were in training, although both might return almost immediately after the games were over. The whole energies of body and mind were devoted in these men to the training of their muscles so that they might gain the prize either for running, wrestling, throwing the discus, or anything of that sort, and so there was no energy, either bodily or mental, left for expenditure in the way of sexual congress.

LECTURE 30.

Conditions affecting the sexual organs, *continued*—Exercise—Sources of local irritation—Acidity—Diabetes—Spinal cord disease—Aphrodisiacs—Emmenagogues—Iron—Manganese — Increased supply of blood—Aloes—Ecbolics—Quinine—Ergot—Action of drugs on the mammary gland—Galactagogues direct and reflex.

GENTLEMEN,

At the end of the last lecture I was mentioning that a good deal could be done towards lessening sexual excitability by directing blood to other parts of the body instead of to the pelvic organs, and this is best done by bodily exercise or mental exercise, carried, perhaps, to the extent of fatigue. There are various kinds of exercise, which differ considerably in their effects. As the object of your treatment is to lessen the amount of blood going to the pelvic organs, you can readily see that exercise with the legs, such as climbing or walking, is not likely to have the effect desired, but that, in fact, it may do more harm than good, because it would appear that, when you have a large artery dilated, you may get a larger amount of blood going to its branches than you would otherwise do. We shall have to consider this presently in regard to menstruation. Exercise of the upper part of the body, however, has no such disadvantages, and exercises in a carpenter's shop are probably as good as can be given to any of your patients, such as planing, hammering, cutting wood, sawing, and so on. In cases where it is impossible for the patient to obtain these exercises, he may get them by regular systematic movements, especially movements of resistance, such as I mentioned to you before when speaking of the treatment of heart disease. The so-called parlour gymnasia may also be used, where the patient has to stretch his arms and draw up weights. In all these movements the upper part of the body and arms are exercised. Severe mental exercise is also a very useful thing by diverting the ideas from sexual subjects. Now, irritation of the urethra by acid urine, as I said before, tends to increase sexual desire, and very frequently the removal of irritation of this sort will so far lessen the sexual appetite that many patients, who have a wrong idea of the amount of it which they ought to have, will complain that certain drugs are very lowering, by which many of them mean that these drugs reduce the sexual desire below what they regard as normal. Amongst those lowering drugs may be mentioned iodide of potassium and alkalies, especially the bicarbonate of potash. Of course the very fact that they do lower the sexual desire is very useful in certain cases, and in many of those instances where patients complain of the lowering effect of the drug it may be well to tell them that this is just what you want, because not unfrequently you may find that the urine is in these cases so excessively acid that it has kept up for a long time an abnormal amount of irritation in the sexual organs which these patients are accustomed to look upon as the normal thing, whereas it is really excessive.

There are certain instances where you get irritation of the genital organs from eczema of the vulva or glans, and in these cases you should always look for the presence of sugar in the urine, because sugar in the urine, like uric acid, may give rise to extreme local irritation, even more than that produced by uric acid. Occasionally you will find that these patients suffer in this way simply because the urine becomes evaporated upon the vulva or prepuce, and forms there small crystals, which give rise to mechanical irritation. I had a most instructive case of this kind. Some years ago a man consulted me for angina pectoris. I examined him, and came to the conclusion that he had no such disease, but was simply suffering from gouty dyspepsia. He had been told not to take any exercise. I told him, on the contrary, he was to take as much as he possibly could. I saw him no more for a good many years, but next time he came to me for an entirely different complaint. He had been perfectly well, he said, but a short while before I saw him the second time his prepuce had begun to swell up enormously, and he was ashamed to show it to his medical man, because he said it looked so suspicious. On examination of the prepuce I saw that it was very much swollen, and I thought it was a case for a surgeon. But the patient said: "I want you to overhaul me, and I will go to the surgeon afterwards if you so advise." On examination I found that his urine contained a quantity of sugar, and that this enormously swelled prepuce was simply due to the crystallisation of the sugar upon the prepuce. I told him to carry with him a small leather pouch containing a sponge, and by simply sponging the mouth of the urethra after each micturition he was completely relieved of all his symptoms. This is a thing that it is well to bear in mind as one of the sources of irritation in the genital organs.

In some cases you may meet with excessive genital irritation due to disease of the spinal cord. You know that in cases of locomotor ataxy patients often suffer from extraordinary shooting pains, which are exceedingly severe and very distressing. On one occasion a patient came to me and complained of being troubled with excessive sexual desires. On examination I found nothing to explain them, except that his knee-jerk was gone, just as it would have been in a case of locomotor ataxy. I regarded his desires as simply another form of the shooting pains which one finds in locomotor ataxy, and which are due to disease of the cord. I treated him by antipyrin precisely in the same way I should have done if he had been complaining of pain, and he wrote to me from India afterwards that the excessive desire which had been the plague of his life had completely gone. So in this case it was evidently due to irritation in the cord itself.

Now sometimes you may be consulted not about excessive sexual desire, but about abnormally weak sexual desire, and this very often comes on in cases of diabetes. It comes on also in cases of numerous other nervous diseases. In many instances it may be simply due to general weakness of the patient. If a man is starved, his sexual desires generally disappear entirely, but if he is well fed with abundance of meat. and especially if he drinks wine as well, he gets increased sexual desire, which is probably due partly to the better nutrition of the nerve centres and partly to the more acid condition of the urine, acting as a local stimulant to the urethra. In all those cases you have to take into consideration two factors: (1) the condition of the general nervous system and (2) the local condition of the sexual organs.

You have to consider cautiously before you increase the sexual desires of any patients, because the loss of those desires is frequently nature's warning that the patient is unable to stand the loss due to sexual coitus, and if the desire and coitus be abnormally stimulated the patient is very likely to die. It is a well-known fact that if an old man marries, and especially if he marries a young wife, he is very likely to die within a year, because the abnormal demands made upon his nutrition are more than the system is able to stand, and so the individual perishes. This is always to be considered very carefully whenever you are asked by your patients to give them something to stimulate their sexual powers.

Aphrodisiacs.—These desires, as I have said, may be increased by general nutrition, and so amongst the aphrodisiacs we have abundant food, especially animal food, wine, cod-liver oil, and iron; in fact, we have all the general foods and tonics. Amongst the special tonics we may probably put in the first rank strychnine, or nux vomica, which not only tends to increase the general nutrition, but seems to act specially as a stimulus to the nervous system and to increase the excitability of the sexual centres. These may be looked upon then as the most important of the general aphrodisiacs. There are some others which appear to have, or are supposed to have, a special action. Amongst these are the various substances obtained from the sexual organs of animals, such as castor, and more especially musk, while other substances resembling these in their odour, such as sumbul and ambergris, are also used in the East for the same purpose. Besides these, it is the custom in the East to use certain narcotics. Now alcohol has a tendency to increase the sexual desires, and at the same time to lessen the power of coitus. The reason of this probably is that, while it has a certain stimulating action upon the nervous system by dilating the vessels of the brain and spinal cord, it has also a certain paralysing power, and by dilating the vessels throughout the body generally it lowers the arterial pressure. Now, a certain amount of arterial pressure is absolutely necessary in order to make the penis sufficiently rigid to enter the vagina, and in consequence of a large dose of alcohol, while the sexual desire is increased, the power of the penis to remain erect is greatly diminished. Probably this is partly due also to the fact that alcohol in large doses tends, to a certain extent, to lessen reflex excitability. A somewhat similar condition appears to be brought on by means of cannabis indica, and this is largely used in the East as an aphrodisiac, but when tried in the West has not had the same effect. In all probability this is due to the fact that the Easterns do not use cannabis indica pure and simple; they combine with it various substances which have a local irritant action upon the sexual organs, and more especially cantharides. Cantharides passes out through the kidneys, and acts as a local stimulant to the kidneys, the bladder, and the urethra, and in large doses gives rise to inflammation of these parts; so that the secretion of urine is arrested, the kidneys become inflamed, and there may be such excessive irritation of the urethra that the penis becomes absolutely rigid and gives the patient the utmost pain. In smaller doses it will act just like very acid urine as a stimulant to the sexual organs, but there is a certain amount of risk in using it.

Emmenagogues.—The same drugs which tend to increase the sexual desires tend also to increase the menstrual flow in women. Drugs which tend to increase this flow are called "Emmenagogues." The flow is often arrested by cold, and one of the most risky things is cold applied to the feet when the menstrual period is on. Sometimes I believe that this occurs through heedlessness. Girls are asked to go for a walk somewhere, and they go out regardless of weather, or they play tennis when the grass is wet, and thus they get their feet wet while the period is on, and the flow stops. Sometimes the flow is deliberately stopped by girls, who purposely put their feet in cold water and arrest the flow, in order that they may not be prevented from going to a ball. Unfortunately it is not arrested for that time only, but it may remain permanently stopped for months, and then, as a curious result, instead of the patient becoming full-blooded and rosy, as one would expect from the stoppage of the monthly losses, she becomes pale and anæmic. The arrest of the menstrual flow, instead of causing her to have more blood, appears to destroy the blood she has, and she becomes exceedingly pale and anæmic. In such cases, of course, you can hardly expect that the flow will tend to come back again of itself, without some assistance, because the anæmia seems itself to lessen the flow. When patients get below a certain point they cannot stand the loss, and yet until the flow does come back they do not get well. In cases of phthisis, the flow very often stops, and it is frequently of no advantage to try and bring it back. You quiet such patients by telling them that they are too weak to stand the monthly drain.

In anæmia, whether it be due to stoppage of the menstrual flow, or to phthisis, or to anything else, you generally find that iron is beneficial. During its administration the period often comes back, and the patient recovers, at least in cases where no such disease as phthisis is present. Iron is, therefore, a powerful emmenagogue. There is another substance, belonging to the same chemical group as iron, which has been supposed to act even more powerfully, and that is manganese. This has been used in the form of peroxide and sulphate of manganese and of permanganate of potash. There is a difficulty about permanganate of potash, inasmuch as it is apt to undergo spontaneous combustion when given in the form of a pill, while it has a very disagreeable taste in the form of a mixture, so that sulphate or peroxide of manganese is frequently given in the form of a pill rather than permanganate of potash. Cod-liver oil and all other good nutrients are also indirect emmenagogues.

Increased Supply of Blood.—I remarked in a previous lecture that if you increase the flow of blood to one part of the body you sometimes increase it also in adjoining parts. If you put your feet some night into hot water and test the size of the artery in the foot before and after you put it into the hot water, you will find that the artery undergoes considerable dilatation. Not only does the foot become rosy, and the capillaries dilated, but the afferent artery is also dilated, feels larger to the finger, and throbs more powerfully. Nor is it only the arteries of the feet that dilate. If you put the finger on the femoral artery you will find that it becomes also dilated and pulsates more powerfully. I have no definite proof that the dilatation proceeds further up than the groin, but if it proceeds up as far as the femoral artery, it seems highly probable that it may go as far up as the iliacs, and if it does so you can readily see why putting the feet into hot water will increase the supply of blood to the pelvic organs. Whether this be the correct explanation or not I cannot possibly say, but I think you will easily convince yourselves that dilatation not only of the arteries in the feet, but also of the femoral artery, is produced by putting the feet into hot water. Practically one knows that putting the feet into hot water is one of the best means of bringing back the menstrual flow, and you generally tell your patient to put her feet into hot water before she goes to bed for three or four nights before she expects the menstrual period to return. Sometimes, instead of merely putting the feet in, you may advise her to take a hot hip-bath and to stay in until the hips are quite red. In this way you get dilatation of the vessels of the pelvis, and the flow tends to return. Not unfrequently the addition of some stimulant, such as mustard, to the foot or hip-bath, increases the effect of the hot water, and you generally order the bath to be used on going to bed, so that the patient runs no risk of catching cold afterwards.

Certain drugs also seem to increase the menstrual flow. Stimulation of the uterus may occur not only from the skin, but from the mucous membrane of the rectum, and so aloes, which has a special action upon this part of the intestine, is a well-known remedy in cases of amenorrhœa. Certain resins appear to have also a stimulant action upon the menstrual flow. One of those is myrrh, and we have this remedy combined with aloes in one of the pills in the Pharmacopœia, viz., that of aloes and myrrh, which is a very useful remedy in amenorrhœa. Aloes may be given in another form, which is very useful, but unfortunately very disagreeable, but still in some of these cases you are bound to get your patient well some way or other. The form I mean consists of equal parts of the compound decoction of aloes and compound mixture of iron. Here we have aloes and myrrh, and potash and iron, the very things that one would theoretically want to bring on the menstrual flow, and to supply the blood with materials for the formation of new corpuscles. It is a very old remedy, but I think it is one of the best we have. Cantharides has also been used for the same purpose; in fact, all the things I have before mentioned as being likely to increase the sexual desire have been used for the purpose of increasing the menstrual flow.

Ecbolics.—When emmenagogues are used in larger quantities and are taken by patients who are pregnant, they tend to cause contraction of the uterus and expulsion of the fœtus. Such drugs are called ecbolics. In many cases this is very disadvantageous, and is a thing to be avoided as far as possible, so that in the case of patients who are suffering from a tendency to premature confinement you tell them to avoid all the things that you would recommend as emmenagogues, to avoid all brisk exercise, to lie up a good deal, to avoid all hot baths, or, at least, to avoid any hot foot-bath or hot hip-bath, and to avoid anything that is likely to cause straining in any way. You would not, therefore, in such cases give an emetic, lest the straining during vomiting might cause abortion. You avoid anything that is likely to irritate the rectum, and so you are told not to give large doses of aloes to a pregnant woman, nor, indeed, to give a drastic purgative of any kind. There are certain other drugs that you must specially avoid; viz., savin, cantharides, and ergot. Now there is one drug which has the reputation of tending to cause abortion or premature labour, and you will be called upon some of these days almost certainly to give it to pregnant patients, and that is quinine. It has been stated that large doses of quinine tend to cause the pregnant uterus to contract, and so to produce abortion. There are many pregnant women who suffer from ague, and the question will be almost sure to come before you: "Am I to give this woman quinine to stop her ague, or shall I run the risk of bringing on abortion by giving it, and get myself into hot water thereby?" The way one generally manages to get out of it is to try other drugs in place of quinine. For example, stop the rise of temperature by antipyrin or by phenacetin, and give arsenic or some of the other substances that may act as antiperiodics; but if the woman is really suffering very much from the ague, I think the risk from quinine is much less than from the ague. You do not give very large doses of quinine unless the patient is very bad indeed, and likely to die of the ague, and then she had better run the risk of abortion than die of the ague, because it is only in very bad cases of pernicious malaria that such large doses of quinine are required as would be likely to bring on premature labour or abortion.

The most powerful of all ecbolic drugs is ergot, and you frequently require to give ergot for the purpose of causing expulsion of the fœtus or of causing the uterus to contract after the fœtus has been expelled. Ergot is given much more frequently to cause contraction of the uterus after expulsion of the child than to get the child expelled, because in cases of lingering labour one frequently puts on the forceps and brings the child away, but if the child is delivered in this way when there is inertia of the uterus, it may remain dilated after the removal of the fœtus. Then the mother's life is in considerable danger, because the open mouths of the uterine vessels allow the blood to flow into the uterine cavity; the uterus becomes filled with blood, which streams in and makes a huge clot; then the uterus expels the clot again, and by repeating this action simply pumps away the life-blood of the patient. What you want to do is to get it to contract firmly, so that there shall be practically no cavity into which the blood can flow, and when you get complete contraction the patient is, of course, safe. In order to do this one frequently uses ergot, and the usual way of applying it is by subcutaneous injection. I do not know that "subcutaneous" is quite the proper term to use here, and yet it is a convenient way of putting it, but instead of injecting it just under the skin, as one does in the ordinary way, we run the needle straight down into the buttock and inject the ergot, not into the subcutaneous cellular tissue, but into the gluteus. The reasons for so doing are that, firstly, if injected under the skin it takes a longer time to absorb, and, secondly, it is much more likely to cause an abscess, whereas if injected deeply into the muscle it is quickly absorbed, and does not tend to cause an abscess. Besides this, you can excite the uterus to contraction mechanically, and this is frequently done by pressing the uterus with the hand, first kneading it and afterwards putting upon it a compress. In order to arrest hæmorrhage and to cause contraction of the uterus, hot water is not infrequently injected into the uterine cavity, which acts as a powerful stimulant to the uterine fibre, and so you get contraction. Regarding this, however, you will hear more fully in your midwifery classes.

Action of Drugs on the Mammary Gland: Galactagogues.—We may now pass to the action of drugs upon the mammary glands. Sometimes we wish to excite the action of the glands, sometimes to stop it. One would expect the mammary glands to be acted upon by drugs in much the same way as the salivary glands, and it is quite true that one drug, jaborandi, has a similar action on both. But in the case of the mammary glands you do not want to cause a profuse flow of milk for one single time, but a long-continued flow of milk several times a day and for months together, so that jaborandi is not much used as a galactagogue. In cases where the milk is deficient, the first thing to do is to get the health of the mother or nurse into good condition. Frequently when nurses come from the country they give very good milk at first, and the town mothers are greatly delighted, but after a short time the milk begins to fail; the nurse begins to get fat; she gets plenty to eat and plenty to drink, with very little exercise, and her milk begins to fall off in quantity. If the nurse is to keep in health she must have plenty of exercise, and often it is advantageous that she should not have too much to drink, and especially that she should not have too much alcoholic liquor. It is usually supposed that stout is an exceedingly good galactagogue. It is to a certain extent, but my belief is that abundance of milk given to the nurse is better than much stout, and if you wish to keep the nurse's health in good condition, then you must be especially careful to give her things that do not disagree with the stomach, to keep the bowels open, and to make her take plenty of exercise. Sometimes the amount of milk may be increased by giving something to the mother which will make the child take the breast more readily. There are various substances which pass out through the mammary glands, and amongst others are the volatile oils. Some oils have got an exceedingly disagreeable smell; they render the milk distasteful, and the child won't take it. For example, asafœtida is a thing that passes out in the milk, and is likely to make the child refuse the breast; oil of onions will also pass out as well, and give an unpleasant taste to the milk. The oils of dill and anise pass out in the same way, but they are relished by the child, so that if you give either of them to the mother the child is likely to take the breast readily, and the greater stimulus applied to the mother's nipple by increased suction on the child's part will act reflexly as a galactagogue, so that oils of dill and anise often stimulate the secretion of milk.

Then every now and again we wish to stop the secretion of milk, and this is effected by a drug which acts on the milk gland in the same way as it acts upon the salivary glands or cutaneous glands: atropine or belladonna. As you know, belladonna or its active principle, atropine, has a local action on various glands as well as upon the eye, and its local action upon the milk gland is to stop the secretion of milk. Generally when you wish to stop the secretion of milk you smear the breast with extract of belladonna or put on a belladonna plaster. Sometimes you cannot stop the secretion of milk entirely, and you wish to relieve the breast, while at the same time you do not wish the child to go on sucking. You may also require to relieve the breast in cases where the nipple is sore, and where the mother cannot bear the pressure of the child's lips upon it. Here you have an artificial means of sucking the milk away, but, as you can see, the upper part of the glass is larger than is likely to be filled completely by the nipple, and so you can withdraw milk from the breast without exercising much power or any pressure upon the anterior part of the nipple itself. The little cap-shaped part of the vessel is applied over the nipple, and then the mother simply sucks the tube, and the milk pours out from the nipple into the little receptacle below. It is to be remembered that there are other things which pass out through the milk as well as oil of anise and oil of dill. Various purgatives pass out, and various alteratives. Iodide of potassium passes out quite readily; so do sulphate of magnesia and the purgative principle of castor oil. Sulphate of magnesia in passing out will probably act as a laxative upon the bowels of the child, but at the same time it is not at all unlikely to give rise to gripes. Acids also tend to cause griping, so that you are rather careful about giving either sulphate of magnesia or acids to a nursing mother. Castor oil may be given without doing any harm. It will simply relax the child's bowels, but it will have no other disagreeable effect, and even when given directly to the child is not likely to cause any griping.

LECTURE 30—*continued.*

ACTION OF GROUPS OF DRUGS.

There are two ways of looking at the action of drugs. There is the way we have been following hitherto, which consists in taking seriatim the various organs of the body and considering how their functions in health and disease are modified by the action of drugs upon them. We have considered drugs hitherto from the point of view of the various systems: the nervous, the muscular, the circulatory, the respiratory, the digestive, and the excretory systems. But nearly every drug has other actions, and acts not upon one organ or system only, but upon several together, and unless we look at drugs from both points of view we shall get a one-sided notion of their actions, and we may not be able to use them successfully in practice. We must now begin to look at drugs from the point of view of individual drugs or groups of drugs.

Oxygen Group.—First of all we will take the group of oxygen. Now oxygen is a very old remedy, and has been used over a century, but it is only within the last two or three years that it has become extensively employed, and the reason is a very simple one. Some fifteen or twenty years ago Sir Joseph Fayrer and I used it in physiological experiments which we were making upon the action of snake venom. We found that by keeping up artificial respiration we could prevent the death of the animal for a long time,* and since that time a man who had been bitten by a snake has been actually brought round from a condition of apparent death by the continuous use of artificial respiration. We thought that probably oxygen would be useful in that condition,† but the only way of getting it was in a gasometer, which Dr. Russell kindly filled for us. Unfortunately,

* Brunton and Fayrer, *Proc. Roy. Soc.*, 1873, vol. 21, p. 372.

† *Ibid.*, 1874, vol. 22, p. 275.

however, the supply of oxygen in the gasometer sometimes became exhausted in the middle of an experiment, and there was no more to be had for a couple of days or so. So you see that the difficulties in the way of using such a remedy clinically were too great, and it could not be employed. Of late years it has been introduced in a compressed form in steel cylinders, and in this way it can be very easily carried about and applied at the bedside. In cases where the aërating surface in the lung is very much reduced we may find oxygen of the utmost possible service. Sometimes it really acts in a miraculous manner.* The cases in which it is probably of most service are those of pneumonia, and especially cases where you wish to tide the patient over a few hours, as, for example, cases where one lung is beginning to clear up, and the other is beginning to get consolidated. Because, in such cases, if you can tide the patient over for a few hours until the lung which was first affected has cleared up sufficiently to allow it to aërate the blood, he may recover; whereas, if you get both lungs affected at the same time to such an extent that the respiratory function cannot be carried on, the patient, of course, must die. If, however, you can give the patient more oxygen at each inspiration, you may, notwithstanding the insufficient capacity of the lung, aërate his blood enough to get him round the corner, and allow him to recover. In cases of bronchitis it is of less service, though there, also, it is sometimes useful.

Ozone has been sometimes advised in cases of phthisis and in cases of purulent infection. It has been said in this latter condition to bring down the temperature very rapidly. I have tried it in phthisis, but have not found it of any great service. It may possibly have some beneficial action, but the action, if any, has not been sufficiently great to bring ozone into very much favour. It is to be remembered that pure ozone is a very powerful irritant, and if you make an animal inhale ozone in a tolerably concentrated form, it will simply be suffocated, for the local irritation to the respiratory passages which the ozone produces is so great as to cause fatal bronchitis.

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* Brunton and Prickett, *Brit. Med. Journ.*, Jan. 23rd, 1892.

You can readily imagine that if we could give oxygen in various forms to the tissues we might get very good results. We should be able to destroy numerous small microbes, because fresh air is one of the most powerful destructants of microbic life that we know. Now oxygen, although it may be carried about in cylinders for use in inhalation, is not so conveniently applied in the gaseous form to any tissues. We have, however, a means of giving it in the permanganate of potash, which yields up its oxygen very readily to any oxidisable substance. This is conveniently carried about in solid form, and when dissolved in water forms an antiseptic lotion which is used for many purposes, *e.g.*, as a lotion to wounds, as an injection into serous cavities and into mucous cavities. It yields up its oxygen so readily that it will not only destroy the life of microbes, but it will destroy toxins. One of the most marked examples of this is cobra poison. In the research with Sir Joseph Fayrer* which I have already referred to, we tried the experiment of mixing cobra poison with many other substances in order to find something that would destroy its virulence. The only new thing we found was chloride of gold, and that was simply due to its forming a firm compound with the cobra poison which practically destroyed its active powers. The effect of permanganate of potash was not our discovery. It was made by Dr. Wynter Blyth, and we simply repeated it, but nothing that we tried had the same power to destroy cobra poison as permanganate of potash. If you take a little permanganate of potash and mix it with cobra venom before introducing it, the activity of the venom is quite destroyed. It is highly probable that many of you will go out to India, Africa, or other countries where snakes abound, and you will be called upon to treat snake bites. The plan of treatment which I should recommend is this. As soon as the bite has occurred, tie something tightly round the member between the bite and the heart; then cut out the part if you can, but if this cannot be

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* Brunton and Fayrer, "Note on the Effect of Various Substances in Destroying the Activity of Cobra Poison," *Proc. Roy. Soc.*, June 20th, 1878, vol. 27, p. 465.

done, enlarge the wound with a penknife. Have with you in your waistcoat pocket a small phial containing permanganate of potash in crystals; and rub some into the wound. If this is done quickly and thoroughly enough, I think it possible that little or no bad result may ensue from the snake bite, but success or failure may depend entirely on the rapidity and thoroughness of the application. I have tried permanganate of potash in the case of a dog bite. When I was out in Hyderabad on the Chloroform Commission, I tried one day to seize a pariah dog in order to chloroform it. These pariah dogs run wild all over the city, and as they live upon all sorts of garbage, the teeth of the dog might have been buried in carrion just before it was brought to us. The risk of infection with pathogenic microbes was therefore very great. The dog seized my hand and bit almost through it. I knew that he had bitten through the palmar fascia, because a little of the fat which lies under it came out upon the palm of my hand. I made a saturated solution of permanganate of potash, soaked a pointed bit of stick in it, stuck the point into the wound, and rubbed it well round. It caused a good deal of pain, so that I very nearly fainted, but the wound healed up by first intention, and I had no trouble with it afterwards. If I had not acted as I did I should in all probability have got an abscess under the palmar fascia and inflammation of the lymphatics, and one never knows how far pus may burrow nor what incisions might be required to let it out. Thus my personal experience seems to show the utility of permanganate of potash in regard to dog bites. Permanganate of potash is also used as a remedy for amenorrhœa, not on account of the oxygen, but of the manganese, it contains. Another drug containing much oxygen, and which is much used, is chromic acid. It is a useful caustic, and may be employed more specially for sores and ulcers in the tongue. We have it in the Hospital Pharmacopœia: the pigmentum acidi chromici. This contains a solution of 10 to 180 grains of the acid, the strength being varied according to the nature of the ulcer to which it is to be applied, and it has the power in many cases of healing up ulcers of the tongue, which do not yield to ordinary treatment.

Sulphur.—This is another drug which belongs to the same chemical group as oxygen, but is different from it in very many respects indeed. Sulphur is solid; oxygen is gaseous. Sulphur has, however, the power of destroying vegetable life to an enormous extent, and its preparations may therefore be used in some degree in place of those that we have just mentioned. One of the best preparations of sulphur for this purpose is sulphurous acid. This is used very extensively in order to disinfect rooms. In a room which has been occupied by a patient suffering from some infective disease you take up the carpet, put into the middle of the room a tub containing water, over the tub put the fire-irons, on the fire-irons put a pan with some sulphur in it, set fire to the sulphur, having previously closed all the windows, and leave the room for a couple of hours or until the sulphur fumes have penetrated everywhere. Do not forget to put the water underneath the burning sulphur, because otherwise it might fall, set fire to the floor, and the house might be burnt down. We have sulphurous acid in the Pharmacopœia in the form of a solution, and this may be applied as a wash for various skin diseases in which parasitic organisms are present, or it may be used as a gargle to the throat and as a remedy in cases of gastric disease accompanied by the presence of numerous organisms in the stomach. In cases of vomiting depending upon fermentation in the stomach sulphurous acid sometimes acts like magic. I have seen cases of vomiting which had gone on for weeks arrested by one dose of a drachm of the sulphurous acid of the Pharmacopœia freely diluted with water. You do not often get it to act so rapidly as this, but after two or three doses you are generally able to stop the vomiting. The drug destroys the organisms, stops fermentation, and gets rid of the irritation in the stomach, and the patient gets well. Sulphurous acid is taken up by fat, and if it be passed into melted fats an ointment may be obtained containing a large proportion of sulphurous acid. This may be used as an application in various parasitic skin diseases. I tried both such an ointment and a solution of sulphuretted hydrogen in favus in 1865, but have never published an account of the trials I then made. But sulphur when applied to any living organism, especially to low organisms, seems to be taken up by the protoplasm and then to combine either with hydrogen or with oxygen, and yield the products of its union, H_2S or SO_2. What occurs in the low organisms occurs also in the higher. If you take some sulphur two or three times a day you will find that it is absorbed from the stomach and intestine probably in the form of sulphide; it is carried by the blood, passes to the skin, and is there excreted in the form either of sulphides or of sulphuretted hydrogen, so that any silver carried about the patient's body, coins, watches, or bangles, becomes blackened by its action. Oddly enough, sulphur is absorbed also from the skin. At one time I did not believe this, but I had a patient who was suffering from rheumatism, and she put sulphur on her stockings and wore them all night. This was absorbed and passed out by the skin so as to blacken her bangles. Sulphur is a substance which is taken up and excreted by living organisms generally, and if it be put on various fungi they do the same: they take it up and then excrete it; but what happens to them is this: the sulphur is transformed by them into sulphuretted hydrogen and sulphurous acid, and these products are fatal to the fungi. So in cases where a fungus is doing harm, as in the case of the vine disease of Italy, powdered sulphur is dusted all over the vine; the fungus takes up the sulphur and forms sulphuretted hydrogen and sulphurous acid, which are fatal to the fungus itself. Before the introduction of antitoxin sulphur was used as a powder to the throat in cases of diphtheria, and there it seemed to have a similar action to what it has in the vine disease, and I have seen very good results from its insufflation. It is also used as a remedy in various skin diseases, for which it is both given internally and used externally.

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LECTURE 31.

Sulphur—Sulphur waters—Charcoal—Halogen group—Chlorine—Bromine—Bromides—Nervous headaches—Epilepsy—Iodine—Potassium iodide—Acids—Hydrochloric acid—Sulphuric acid—Nitric acid—Phosphoric acid—Sulphates as alteratives—Acetic, tartaric, citric, acids—Boric acid—Hydrocyanic acid—Prussic acid poisoning—Treatment—Alkalies, volatile and fixed—Ammonia—Soda—Potash—Lithia.

GENTLEMEN,

At the end of the last lecture we were discussing the action of sulphur, and I said that sulphur when applied externally was useful as a destructive agent to small organisms, both animal and vegetable. It may be used in order to destroy the small fungi which occur in parasitic skin diseases, or it may be employed in order to destroy the small acari or mites which give rise to scabies or itch. Sulphur ointment is used for this, and it seems to have a greater action in destroying those creatures than simple fat has, although fat alone destroys them by filling up their spiracles or breathing pores.

When taken internally, sulphur acts first of all as a slight stimulant to the intestine, causing the motions to become somewhat softer and somewhat more frequent than before. Sulphur is, therefore, used as a laxative especially where there is much pain or irritability about the anus, as in cases of hæmorrhoids, or fistula, or fissure of the anus, or in cases where we wish to avoid straining, as in pregnancy, especially with tendency to abortion. Sulphur may be given in the old-fashioned way with treacle and cream of tartar, or it may be given in the form of a little of the confection of sulphur of the Pharmacopœia, which is supposed to be a somewhat more elegant preparation, or it may be used in the form of lozenges, two or three at night being frequently sufficient to cause regular easy action of the bowels. Sulphur is absorbed both from the skin and from the mucous membranes; by the blood it is carried to all the tissues, and so acts as an alterative; it is eliminated both by the skin and by the lungs. It is very useful in cases of gout and in rheumatism, and is frequently employed in the form of natural sulphur waters. You know that the Chelsea Hospital used to be a refuge for old soldiers, and those who had seen much service were frequently afflicted with chronic rheumatism. The joints became sore, stiff, and painful, so that the old veterans could hardly move, and the Hospital used to keep in stock a confection which was found to be of great use to the old fellows. In our Hospital Pharmacopœia we have a compound confection* of sulphur which is an imitation of this medicine. The active ingredients of this confection are sulphur and guaiacum, and it is a very useful remedy in cases of old chronic rheumatic affections of the joints.

The sulphur waters that are the greatest favourites in the treatment of gout and rheumatism are at Harrogate, Moffat, and Strathpeffer, in this country, and abroad Aix-les-Bains, Aix-la-Chapelle, and several baths in the Pyrenees, Cauterets, Vernet-les-Bains, Bagnières de Luchon, Bagnières de Bigorre, Amélie-les-Bains, and some others. These are all available in summer, but as a rule the choice of sulphur waters for our patients is limited. In our own country we have the three I have mentioned, and in France we have Aix-les-Bains. Aix-la-Chapelle is equally good, but at the latter place a number of patients are treated for syphilis, and along with the administration of the waters inunction cures are there employed. This has become so widely known amongst the general public that many patients suffering from rheumatism, to whom the waters

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* Confectio Sulphuris Co.

$\left\{\begin{array}{l}\text{Sublimed sulphur, 100 grains}\\ \text{Acid tartrate of potash, 25 grains}\\ \text{Treacle, to } \frac{1}{2} \text{ an ounce}\end{array}\right\} = \begin{array}{l}\text{Confectio Sulphuris, St. B. H.}\\ \text{Pharmacopœia, } \frac{1}{2} \text{ an ounce.}\end{array}$

Guaiacum resin in powder, 80 grains.
Rhubarb root in powder, 40 grains.
Nutmeg in powder, 40 grains.
Treacle by weight, to 1 ounce.
Dose 2 to 4 teaspoonfuls.

would be undoubtedly beneficial, will not go to this place lest their friends should suspect them of having syphilis. The baths in the Pyrenees are exceedingly good, but they are nearly all occupied by French people, and the Englishman abroad is a gregarious animal and travels where other English people go, so it is hardly worth while to advise patients to go to the baths of the Pyrenees, because they will not find other English people there. They therefore generally go to Aix-les-Bains. There are very few sulphur waters to which you can send patients in winter. Almost the only one I know is at Helouan, which is about three-quarters of an hour's ride from Cairo. There are frequent trains, just like the Metropolitan Railway here, which take patients backwards and forwards, so that they can either stay at Helouan and have the baths or live in Cairo and run in and out daily for them.

There are three places in the Pyrenees where patients can go in the winter, but there again the same objection holds: English people are not to be found. These are Bagnières de Bigorre, Amélie-les-Bains, and Vernet-les-Bains. Vernet is a place that is very little known; it was bought by the great Portuguese financier Count Burnay, better known from the large quantity of port wine which he put upon the market some years ago. He bought up this place and converted it into a very good watering-place, taking great care with regard to the hotels and sanitary arrangements, so that it offers the advantage of being a very clean place, and so is suited in this way to English ideas. Its disadvantage is that few people go there, and so it is rather dull.

Charcoal.—We may now pass on from sulphur to charcoal. Charcoal is an exceedingly useful remedy in cases of dyspepsia. It is usually given in the form of charcoal powder, or biscuits, or lozenges. I think it is probably more efficacious if you give it in the form of powder. It is somewhat disagreeable to take, but the difficulty may be got over by putting the powder in a cachet. It may be administered alone or along with pepsin. How it acts one really does not know, but at all events charcoal very frequently serves to give relief to a patient who is suffering from dyspepsia, especially when this is associated with a large amount of flatulence. Both vegetable and animal charcoal are frequently employed for decolorising, especially animal charcoal. It removes the colouring matter from alkaloids, and so it is used to bleach them, but in the process of bleaching a large quantity of the alkaloid itself sticks to the charcoal and is carried down, so a good deal is lost. In bleaching quinine, for example, some of the alkaloid is lost, and the price of the bleached article is consequently higher. Charcoal has been given internally in cases of poisoning by alkaloids, on account of its power of carrying them down, and it is administered in large quantities, generally by the tablespoonful. Charcoal has the power also of absorbing oxygen and giving it off again, so that it has been employed as a disinfectant and deodoriser. For example, when mixed with decomposing meat it completely destroys the effluvia and prevents any harm arising. It has been used in the form of a respirator for people who are obliged to go into places where disagreeable odours occur, as in sewers, and so on, and it is said to be useful in this form.

Halogen Group.—We come now to a very important group, viz., the halogens: chlorine, bromine, and iodine. These have all a remarkable affinity for hydrogen, which they take up very readily, so that they split up water under the influence of light, taking up hydrogen and setting oxygen free. On account of this property, chlorine has a bleaching power, and is frequently used for this purpose. It is supposed that it does not bleach directly by combining with the colouring matter, but indirectly by decomposing water and setting free oxygen, which destroys the colour. For if a piece of coloured material be exposed to chlorine the chlorine will not bleach so long as both it and the material are quite dry, but as soon as water is present it becomes decomposed, yielding oxygen, and the bleaching process commences at once. Iodine and bromine cannot be used for bleaching, because they have such staining powers of their own. They all have the power of destroying low organisms, and they can all be used as disinfectants. Chlorine is sometimes employed for this purpose in gaseous form, but it is not so good as sulphurous acid. It is sometimes used in sick-rooms, and you will sometimes see saucers of chloride of lime placed about with the idea that it is disinfecting the air; but if you come to consider how very weak the chlorine is which comes off from those saucers, you can readily understand that it is not at all likely to destroy microbes. Before the chlorine became strong enough to destroy any low organisms it would be strong enough also to make any one who entered the room very uncomfortable; in fact, it would be almost impossible to live in an atmosphere of chlorine strong enough to be really a disinfectant. Chlorine water is sometimes, however, employed as a gargle in cases of septic sore throat, and we have in our Hospital Pharmacopœia a wash containing chlorine, which is sometimes used, and which is made in a somewhat different manner from that in the British Pharmacopœia. In the British Pharmacopœia the chlorine water is made simply by saturating water with chlorine in solution, but in the one that we have in the Hospital Pharmacopœia chlorate of potash and hydrochloric acid are used, the acid being added to the chlorate in a large bottle, and then, after the chlorine which is thus disengaged has displaced the air, water is added. This is a much more convenient way of getting chlorine water than the British Pharmacopœia one, because it can be made up at any dispensary or by any doctor who has a practice in the country; whereas the British Pharmacopœia method is a troublesome one, and involves a certain amount of apparatus and the expenditure of more time. This is a very good gargle for use in septic sore throat, whatever the nature of the septic organism may be; so that it is applied in various sore throats where we suspect organisms to be present, as well as in cases of diphtheria. Chlorine may be employed also in the form of solution of chlorinated lime or of chlorinated soda, in which the chlorine is held in loose combination with the lime or with the soda. It may be displaced by carbonic acid, or still more quickly by mineral acids. These solutions of chlorinated lime and chlorinated soda may be used to disinfect bed-linen or clothing, closets, or bed-pans. For these purposes chlorinated lime is chiefly used, as it is cheaper than chlorinated soda. The liquor sodæ chlorinatæ and liquor calcis chlorinatæ are also used to disinfect the hands, and as gargles to the throat. They have been given also internally in doses of 10 or 20 minims, although their use internally is somewhat doubtful.

Bromine.—Bromine is also a disinfectant, but, on account of its disagreeable smell, is hardly ever used. Its chief employment is in the form of the bromides either of potassium, sodium, or ammonium. I must mention now the general actions of those three bases. Sodium is more or less indifferent; potash is somewhat depressent; ammonium is somewhat stimulant; so that we get different results from the bromine according as it is combined with those three different bases. The effect of a bromide is that of a nervine sedative; it lessens the activity of the nervous system, tends to prevent excessive irritability, and more especially tends to prevent that irritability which shows itself in epileptic convulsions. It may be used, however, in order to lessen nervous excitability of almost all kinds. For example, it is very much used as a hypnotic; it does not force sleep, like opium, but it tends to induce sleep. There are many cases where people cannot get to sleep, and whenever they lay their heads down upon the pillow all sorts of disagreeable thoughts and ideas flow through their minds. In such cases bromide of potassium is often a most useful hypnotic. It is used also to lessen the irritability which shows itself in explosions of bad temper, and it is a most useful thing sometimes to lessen worry. The chances are that some of you will suffer a good deal from worry in your practice, because, however careful a man may be about his patients, every now and again he is troubled with the feeling that if he had only done something else he might have saved a patient who has died, and not unfrequently he blames himself for the misfortunes of his patients when they are really due to no fault of his and could not be averted by any human power. This worry is all the more likely to take effect if a man is run down, and in such cases the simple administration of 20 or 30 grains of bromide of potassium, especially if combined either with a little bicarbonate of potash or with a little salicylate of soda, will often give great relief, so that after twenty minutes or so the man is better; he feels as if he had slept over the worry, recognises the uselessness of it, puts it on one side, and begins to work at something else. Bromide of potassium is a very useful thing to overworked doctors.

Many people also suffer from headache, and sometimes nervous headaches are a perfect plague, because people, especially when they are hard-worked, never know when one is going to come on, and, just at the very moment when they want all their energies, on comes this troublesome headache, the pain of which is so excessive that the man can hardly do anything involving either thought or action. In many cases the headache may be prevented by the use of bromide of potassium and salicylate of soda taken at night; 20 or 30 grains of bromide, with 10 or 15 of salicylate of soda, taken at night will often prevent the occurrence of headache in the morning. If the patient awakes with a headache, then he should take this dose at once and go to sleep, or at least lie down again for a few minutes, and if the headache does not pass off, then a second dose may be given in a quarter of an hour or so. This may be repeated two or three times if necessary, and the chances are that the patient will then have a comfortable day, instead of being prostrated by continuous pain. This medicine sometimes cures patients almost entirely of nervous headache. I do not know that I have had so much gratitude expressed by patients about any other remedy; they have been simply delighted at getting relief so rapidly. I have said the dose may be repeated up to three times. Well, this seems rather a large dose, because it really means 90 grains of bromide of potassium and 45 of salicylate of soda, but it is unnecessary to push the remedies to such an extent unless the patient is very bad.

In nervous irritability of all kinds you will find bromide of potassium a useful remedy. You will be asked whether there are no bad results to be feared from a continued use of it. I have never seen any bad results. It may be used to such an extent that the patient becomes so drowsy that he can hardly hold his head up, and yet when you stop the administration you do not find any bad effects. At any rate, you can always drive the bromide out of the system by the simple use of an extra quantity of common salt and water. Let the patient take more common salt, *i.e.*, more chloride of sodium, with his meals, and it will drive out the bromide of potassium from the body, and restore it to the normal condition. Where the heart is at all weak, you may give bromide of sodium or bromide of ammonium in place of bromide of potassium, because sodium is, as I have said, indifferent, and ammonium is rather a stimulant. In some cases of epilepsy it has been said that the best results are obtained from a mixture of the bromides of potassium, sodium, and ammonium—10 grains of each. As a rule, in cases of epilepsy 10 grains either of a single bromide or of mixed bromides three times a day are not very much use, and one is obliged to run up the dose to 30 or even 60 grains three times a day. In cases of sea-sickness bromide of potassium is a useful remedy. Persons who are going across the Atlantic, and who suffer from prolonged sickness, may take bromide of potassium during the whole journey without any bad result being experienced after they reach the shore. The only disadvantage I know from bromide besides its soporific effect, which makes people sometimes drowsy during the day when they want to be busy, is that it tends to bring out a crop of pustules upon the skin. It is said that this may be avoided to a considerable extent by mixing with the bromide a few drops of liquor arsenicalis, usually one drop to every 10 grains of the bromide.

Iodine.—Iodine has a strong antiseptic power, but is rarely used for this. I have seen it used in order to destroy organisms about the roots of the teeth, and a mixture containing tincture of iodine and of glycerine of tannin simply painted on the tonsils is often very useful as a remedy in cases of tonsillitis. Iodine is chiefly used externally as an irritant, its great advantage being that we are able to graduate the intensity of its action so exactly. It is applied as a paint to enlarged joints, to enlarged glands, and as a counter-irritant in cases of inflammation of the lungs, commencing consolidation, or to lessen the adhesions remaining after pleurisy or pericarditis. The usual rule is to paint on either the tincture, the liquor, or the liniment as often as the skin will stand it. Very frequently a delicate skin will not stand the application more than once; so that if you are using the linimentum iodi as a counter-irritant in cases of commencing phthisis you very often apply it to the skin over one fourth of the consolidated area one day, over the second fourth on the next, over the third fourth on the third day, and over the remaining fourth on the fourth day, and on the fifth day begin again and go over the same ground.

When taken internally, iodine is a powerful irritant. It is rarely used internally in its pure form, and is generally given in the form of iodide of potassium. It has been supposed, however, that iodine acts better when administered in the free form than in that of a salt; so that it is sometimes given internally in the form of liquor iodi or tinctura iodi in doses of 5 to 10 minims. It has been used for the purpose of checking vomiting, and to relieve pain and swelling and stiffness in cases of chronic rheumatism. Iodide of potassium when given internally has a powerful action upon mucous membranes. It is absorbed from the stomach; it passes with the blood to the salivary glands, where it is excreted, and acts as a sialogogue. It passes to the mucous membrane of the nose, so that the nose tends to run profusely, and patients taking the drug will often tell you that they have had a cold ever since they saw you last, which means that the iodide of potassium you have given them is being excreted by the nasal mucous membrane. I remember a very interesting case of a man who was suffering from syphilitic nodes on the tibia. He had been taking iodide of potassium for not less than three years in doses of 5 grains three times a day with little effect, and the pains at night were so great as to interfere much with his sleeping. I at once increased the dose to 10 and then to 15 grains, and in a few weeks the nodes had almost completely disappeared. In this case the doctor who had previously seen him had employed the right remedy, but did not get the desired result because the dose was insufficient. It is supposed that the secretions from other mucous membranes are affected in like manner; so that mucus from the throat, trachea, and bronchi becomes thinner, and is expectorated more easily. Very probably also the mucus from the digestive passages and from the genito-urinary passages is affected, but the iodide of potassium is not used for its local action upon the stomach. There is one point about it that you require to pay attention to, viz., that free iodine is much more irritant than iodide of potassium. If you give impure iodide of potassium containing iodate it becomes decomposed by the acid of the gastric juice, free iodine being liberated, which is likely to irritate the stomach. This may happen even with small or moderate doses, though not so much as if you were giving large doses, when great irritation of the stomach may be produced, leading to weakness, nausea, and vomiting. The reason of this is that if the pure iodide be mixed with an acid you get only hydriodic acid liberated; but if you have a mixture of iodide and iodate a reaction takes place between the hydriodic acid and the iodate, with liberation of free iodine, which may cause severe gastro-enteritis.

As an alterative, iodine is used for its effect upon rheumatic tissues, rheumatic swellings, and rheumatic pains in nerves, and also for its curious power of relieving the lesions of tertiary syphilis. It has the power also of eliminating lead and mercury from the tissues. It frees them from their compounds with albumin in the tissues, and allows them to pass into the blood, and then they become eliminated by the various excretory channels. In some cases of tertiary syphilis iodide of potassium has been employed with but little result, and then it has sometimes been found that mercury had not been given previously. In such cases we frequently employ a mixture of mercury with iodide of potassium, and we have in the Hospital Pharmacopœia a draught which is very often given: Haustus Hydrargyri Perchloridi cum Potassii Iodido. This contains 5 grains of iodide of potassium along with $\frac{1}{16}$th of a grain of perchloride of mercury. Now, although perchloride of mercury is put in, the draught does not really contain it. It contains periodide of mercury dissolved in excess of iodide of potassium. The dose of iodide of potassium is for certain diseases a small one. If you wish to get increased secretion from the mucous membranes, for example, from the nose or from the trachea, you give it in small doses, from half a grain to about 2 grains. Where you wish to obtain its alterative results in rheumatism, you generally give it in 5-grain doses; but in cases of syphilis you sometimes have to give it in much larger doses, 10, 20, or even 30 grains as a dose three times a day.

It is a curious fact that small doses of iodide of potassium are much more liable to cause running of the nose than large ones. Doses from a half to 2 grains almost always cause profuse running of the nose, and 5 grains frequently do it, but doses of 10, 15, 20, or 30 are much less likely to do so. As a rule, then, if you find that iodide of potassium is producing unpleasant running in the nose of your patients, you may stop the discharge and relieve the discomfort in two ways: either by discontinuing the drug or by doubling the dose until the existing discharge ceases. I have in one or two cases seen the discharge persist even with large doses, but this is very rare.

Now, iodide of potassium is very useful also in aneurism; it relieves the pain of aneurism more than any drug I know; but here also you require to give it in large doses, and I do not think it is much good in any less than 30-grain doses three times a day. In cases also where you find that the heart tends to be feeble, you may give, in place of the iodide of potassium, iodide of sodium or iodide of ammonium. The latter is, however, much less used than the iodide of sodium. Iodide of sodium is frequently prescribed instead of iodide of potassium. Now iodide of potassium is such a powerful alterative that it is very often successful in cases where other things fail. If you have a drug which is useful for rheumatism, gout, and syphilis, you can readily see to what a very large proportion of the population it is likely to be serviceable. While on duty in the casualty department of this Hospital I have seen altogether about 300,000 patients. Out of all this large number I received two letters from various parts of the country saying that the patients had been under many medical men, but they had never obtained any benefit till they came to St. Bartholomew's. They wanted to know the medicine that had done them so much good. In both instances it was the Haustus Hemidesmi cum Potassii Iodido.* Frequently when a doctor does not exactly know what is the

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* Potassii iodidi, gr. v.
Decoc. hemidesmi co., ad ℥i.

matter with his patient he prescribes iodide of potassium; so that as a sort of general rule in cases where you do not know what to give you are very likely to give, and often with good result, iodide of potassium.

I should mention that iodine has the power of lessening glandular structures, and has been given internally, as well as applied externally, in cases of enlarged glands. It is said that when given in very large doses it has the power of causing atrophy even of healthy glands, such as the testicles and mammæ, but such atrophy is of very rare occurrence indeed, although cases have been recorded in which it actually seems to have happened.

ACIDS.—We may pass on now to the acids, and we have two groups of acids, viz., the inorganic and the organic. The chief inorganic acids are hydrochloric, sulphuric, nitric, and phosphoric; the chief organic are acetic, tartaric, and citric. All these acids are refrigerant and sialagogue, as I have already said (p. 375). In addition to this, each acid has a special action of its own, hydrochloric being chiefly used for its action on the stomach, sulphuric on the intestine, nitric on the liver, and phosphoric acid on the urine.

They all tend to neutralise any free alkali that may be present in the skin or in the stomach or intestines, and to convert these alkalies into neutral salts. The neutral salts thus formed will have distinct actions of their own, different both from the original free alkali and from the acid.

Hydrochloric Acid.—Hydrochloric acid is given either immediately before or just after meals in order to aid digestion. It is frequently given before meals in cases of acid dyspepsia, with the idea that it lessens the production of acid, either by preventing the stomach from secreting such acid gastric juice as it otherwise does, or because hydrochloric acid when thus given tends to destroy any small organisms, which after the meal had been taken would cause fermentation with evolution of gas and formation of acid.

Sulphuric Acid.—Sulphuric acid is chiefly employed in cases of diarrhœa, and also in hæmoptysis. It seems more especially to be useful in the diarrhœa that so frequently comes on in cases of advanced phthisis, and aromatic sulphuric acid in 10-minim doses often yields very good results.

Nitric Acid.—Nitric acid is given, as I have said, in diseases of the liver, so-called biliousness. There are many cases in which you find that bile appears to undergo a certain amount of decomposition; so that sulphuretted hydrogen is formed and is belched up, and the patient is annoyed by a disagreeable smell of rotten eggs. In such cases nitrohydrochloric acid generally removes these disagreeable symptoms. There is another condition due to some perversion of nutrition in which oxaluria is brought about, a large quantity of oxalate of lime crystals appearing in the urine. This is frequently accompanied by intense nervous depression without any apparent cause. This condition of oxaluria, with nervous depression, is generally relieved by the use of nitrohydrochloric acid.* This acid, as given in our Hospital Pharmacopœia, is exceedingly useful as a tonic also, and may be advantageously combined with 5 to 10 minims of tincture of nux vomica and 5 to 10 minims of liquid extract of cinchona, or with a grain or a grain and a half of quinine. This combination acts as an exceedingly useful tonic either before or after meals.

Phosphoric Acid.—Phosphoric acid is also employed in place of nitric acid, and is given more especially in cases where the urine is alkaline, and where you wish to render it acid. The advantage of phosphoric acid is that it may be given in large doses without disturbing digestion. If the other acids are given in too strong doses or for a good long time together, they are very apt to cause a condition of gastro-intestinal catarrh, giving the patient so-called dyspepsia.

In speaking of the sulphuretted hydrogen from the stomach and from the intestines, I ought to have noted that you not only get this evolved from the intestines when patients are taking sulphur, but you get a similar result from the administration of sulphates. If you give sulphate of soda or sulphate

* Haustus Acidi Nitrohydrochlorici, St. B. Ph. :—
Acidi nitrohydrochlorici diluti, ♏x.
Tinct. aurantii, ♏xx.
Aq. chloroformi, ad ℥i.

of magnesia as a purgative, and it is not completely evacuated, it is very likely indeed you will find that the patient tells you afterwards that he is passing wind that has a disagreeable smell. The reason of this is that the sulphates undergo reduction in the intestine, and you get sulphuretted hydrogen formed; but it is quite likely, I think, that this reduction of the sulphates to sulphides is of great utility in many cases of disordered digestion and disordered tissue change generally. For sulphate of magnesia and sulphate of soda probably have a considerable effect upon the tissues in addition to that which they have upon the intestine, because by their decomposition sulphides are formed, and sulphuretted hydrogen is set free, so that a good deal of sulphur will probably be absorbed, and thus a beneficial effect upon the tissue change will be obtained. Boils, for example, are sometimes treated by sulphur, but in handbooks on rowing you will generally find directions not only how to feather your oar, but also how to treat boils, for rowing men are very apt to get boils, not singly, but in crops. The great remedy recommended in some of these books is sulphate of magnesia, and its usefulness is probably due, not simply to its purgative, but partly also to its alterative, action.

Acetic, Tartaric, Citric, Acids.—Acetic, tartaric, and citric acids differ from those which I have just mentioned inasmuch as, though they are direct, they are not indirect acids; they neutralise acid in the stomach, but they do not render the urine acid, and if you give acetic, citric, or tartaric acids along with an alkaline base they tend to render the urine alkaline, for these organic acids, when given in combination with a base, undergo combustion in the body, and are converted into carbonic acid, and pass out in the urine as carbonates. Their main use is as thirst quenchers, but acetic acid, when applied to the skin, tends to lessen irritation and itching, and it is frequently used as a lotion to lessen irritation. It is used also as a cooling application to the head in fevers or in headache. Tartaric acid is not much used by itself, excepting to quench thirst, and then it is more generally employed in the form of acid tartrate of potash. Citric acid appears to have a use beyond that of the others, inasmuch as citrate of calcium and oxalate of calcium are both insoluble. I showed you before that if you precipitate calcium from the blood you lessen its coagulability or destroy it completely. In cases where there is a tendency to excessive coagulation and the formation of thrombi, oxalic acid has been suggested as a remedy, but this is a dangerous acid to give, and so in place of it citric acid has been used. Patients, therefore, who have a tendency to thrombi may be advised to drink citric acid freely mixed with water.

Hydrocyanic Acid.—There are two other important acids, which, however, hardly act as acids, but have specific actions of their own. These are boric acid and hydrocyanic acid. Boric acid is simply used as a germicide. Hydrocyanic acid has a peculiar power of acting as a nervine sedative. It is used externally to relieve irritation and itching, but the great disadvantage of it is that it is such an exceedingly powerful substance that you cannot apply it over any large extent of surface at once without running the risk of poisoning. Internally it is given in order to lessen irritation in the stomach and thus to stop vomiting, and also to lessen cough, especially where this is associated with disorder of digestion. The dose of it is one that must be remembered. It is such an exceedingly powerful drug that we have no strong hydrocyanic acid in the Pharmacopœia. We have only the dilute acid. This contains no more than 2 per cent. of real acid, and yet, dilute as this is, the dose of it is only about 5 minims up to 8 minims. The ordinary dose may be said to be 5 minims. This is one of the drugs of which you must recollect the dose, because an overdose of it would tend to produce death. When given in a concentrated form it kills almost like lightning. The effect is so exceedingly rapid that man or animal poisoned by it dies as if struck by lightning. He falls without motion or sensation, respiration ceases, and in a short time afterwards the heart also ceases. In cases of this sort the plan to adopt is to keep up artificial respiration, because the heart will often continue to beat for a long time, and the acid being very, very volatile, soon passes off. You will find that various antidotes of a chemical nature are recommended. You are told to give the freshly precipitated oxide of iron with some magnesia, but this is of comparatively little use, because long before anybody has reached the bottles containing it, even although they are quite handy, the patient will be dead. The great remedy to use is artificial respiration, and cold affusion has also been recommended. Cold affusion is of comparatively little use, but if you can keep up artificial respiration for a sufficient length of time it is very likely you will get your patient round. A curious story appeared in a paper a little while ago about a dog which was a great favourite of its owners. It had become ill, and they wanted to kill it quickly by giving some prussic acid. A big dose was given, and the animal apparently fell quite dead. It was thrown out upon the dung-heap. A small boy being very anxious to possess the dog's tail, which was a magnificent one, took a knife and tried to cut the tail off. In the middle of the operation the supposed dead dog got up and ran away. Probably the stimulation of the operation caused a deep inspiratory effort, which brought the animal round.

Boric acid may be not only used as an antiseptic, but also, like hydrocyanic acid, to lessen itching, and it is frequently employed as a remedy, especially to the vulva and vagina, in order to lessen excessive secretion or irritation in those parts.

Alkalies.—We come now to alkalies. They are divided into two groups: the volatile and the fixed. The volatile alkali is ammonia, and the fixed alkalies are soda, potash, and lithia. To these we may add also magnesia, for, though it belongs to a different chemical group, it agrees with them to a great extent in its physiological properties. They all have the power of combining with acids and forming salts. Alkalies, when applied to the skin, act as powerful irritants. Ammonia does not destroy the epidermis, which, therefore, remains, forming a cover to the true skin, but the ammonia penetrating through it acts upon the dermis, causing effusion of fluid and the formation of a bleb. It may be used as a vesicant in a very simple way: by cutting a little bit of lint or of blotting paper rather smaller than the size of the bleb you wish to produce, soaking this in liquor ammoniæ, putting it upon the skin, and covering with a watch-glass. You leave it there until you see a little ring of red appearing round the edge of the watch-glass, and then, if you take it off and put on a poultice, a bleb soon forms. This is sometimes very useful in cases where you wish to apply a blister in persons suffering from kidney disease, and where you are a little afraid of using cantharides, lest it should be absorbed and act as an irritant upon the kidneys, which, being already diseased, you may be anxious to soothe rather than to irritate.

Caustic potash and soda not only have an irritant action, but they destroy the epidermis itself, and then act upon the tissues below, forming with them a kind of soap. This soap may be easily scraped away, and you may then apply more of the alkali until you get the eschar to the depth you desire. But you must remember that, although when you apply nitric acid the part you destroy is nearly the same as that to which you apply the acid, this is not the case with alkali. In the case of nitric or nitrohydrochloric acid the escharotic limits the extent of its own action by making an insoluble compound with albuminous tissues and forming with them a regular wall, through which the acid does not penetrate. In the case of alkalies there is nothing to neutralise their action, and it extends a good deal further than you would expect.

When taken internally, these three substances—ammonia, soda, and potash—have different actions, as already stated. Soda is indifferent, ammonia is a stimulant, and potash is depressent. Ammonia is a powerful stimulant. When it is applied to the nose by inhalation, it causes reflex stimulation of the vaso-motor centre, with contraction of the blood-vessels and rise of blood pressure, so that in cases of fainting it is very useful. It is also a powerful stimulant when given internally in the form of sal volatile, and one great advantage it has over brandy or whisky, or other forms of alcohol, is that you are not likely to get a habit formed by its administration as a stimulant. If taken in too large quantity, it tends to cause nausea and vomiting. It does this much more quickly than spirits, and so it forms a bar to its own too extensive use. It is frequently employed as a stimulant in fainting, or when the pulse becomes very small or weak. In cases of poisoning by poisons or toxins you may give carbonate of ammonia as an emetic, in order not only to produce vomiting, but to bring about stimulation of circulation, and it is often used for this purpose. In cases of bronchitis, where the patient's bronchial tubes are choked with mucus, and where you do not wish to give such drugs as antimony or ipecacuanha, for fear of depressing the already weakened heart, you generally choose 20 or 30 grains of carbonate of ammonia as being a powerful emetic and, at the same time, a stimulant. The carbonates of potash and soda are frequently employed for their antacid action upon the stomach. When given in small doses before meals, they tend to cause stimulation of secretion, and thus to increase both the appetite and the digestive power. In the Hospital Pharmacopœia we have the Haustus Calumbæ Alkalinus* and the Haustus Gentianæ cum Rheo Alkalinus,† both of which have a small quantity of bicarbonate of soda, and both of which are amongst the most useful remedies we have for indigestion. These ought to be given about twenty minutes before meals. When given after meals, potash and soda are generally used for a different purpose, viz., in order to neutralise any acid that may be present in the stomach. By this means you are frequently able to relieve a patient considerably from the feeling of acidity, or so-called heartburn, and also to arrest the pain which comes on in cases of ulcer either of the stomach or of the duodenum. In such cases you must give the drug in larger doses, half a drachm or even a drachm of the bicarbonate of soda freely diluted with water. Although this relieves the pain, one does not know exactly what effect potash or soda may have upon an ulcer in the stomach or duodenum. In one case, where I was called in on account of

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* Formula for Haustus Calumbæ Alkalinus :—
Sodii bicarbonatis, gr. x.
Tincturæ calumbæ, } *aa* ♏xx.
Tincturæ aurantii, }
Aquæ chloroformi, ad ℥i.

† Formula for Haustus Gentianæ cum Rheo :—
Sodii bicarbonatis, gr. x.
Tinct. gentianæ co., ♏xxx.
Infusi rhei, ℥ss.
Spiritus chloroformi, ♏x.
Aq. menth. piperitæ, ad ℥i

duodenal ulcer with excessive pain, I advised the administration of bicarbonate of soda. This immediately relieved the pain, but a few days afterwards hæmorrhage came on, and then it occurred to me that it was just possible that the bicarbonate of soda might have rendered the tissues in the base of the ulcer more flabby and more feeble, and that the vessel might have given way in consequence. In order to avoid anything of that sort, I am now in the habit of giving along with the bicarbonate of soda a certain amount of lime, so as to counteract any softening effect, for example, a teaspoonful of bicarbonate of soda dissolved in a tumblerful of lime-water.

LECTURE 32.

Carbonates and bicarbonates of the alkalies and alkaline earths—Lime-water—Acetates—Citrates—Tartrates—Neutral salts — Chlorides—Sulphates—Phosphates—Lithia—Magnesia—Zinc group—Sulphates of zinc, copper, aluminium—Nitrate of silver—Astringents—Mercury—Antiseptic—Alterative—Cholagogue purgative—In syphilis—Mercurialism—Mercuric tremors—Lead.

GENTLEMEN,

At the end of the last lecture we were discussing the action of carbonates and bicarbonates, and I mentioned that ammonia was a powerful stimulant, and that caustic ammonia or carbonate of ammonia might both be used as stimulants, externally by inhalation and internally by means of the stomach. The bicarbonate of soda is a useful adjunct in the treatment of dyspepsia, stimulating secretion of gastric juice when given in small quantities before meals and lessening the pain which occurs from irritation of the stomach by the presence of acids, particularly if the acid be in large quantity, or if the stomach be ulcerated.

Now there are certain differences in the local action of some of those carbonates and bicarbonates. Bicarbonate of soda is, as I have mentioned, chiefly used for its local action upon the stomach; bicarbonate of potash and bicarbonate of lithia are more used for their general action as alteratives, modifying tissue change, especially in gouty patients. Magnesia and its carbonates are used both as local antacids to lessen pain in the stomach and also to produce a slight laxative effect in the intestines. Lime in its caustic form is comparatively little used, although formerly a paste consisting of lime and caustic potash was frequently employed as an escharotic; but lime in dilute solution is very commonly used in the form of lime-water. This is employed externally along with linseed or olive oil as a local sedative application. The mixture with olive oil is known under the name of the linimentum calcis of the British Pharmacopœia. In the Hospital Pharmacopœia linseed oil is used instead of olive oil, and this preparation is an imitation of an old-fashioned remedy called carron oil. I daresay many of you have read Marryat's novels in which he speaks of carronades, a kind of short gun carrying a heavy ball, which was much used in the navy a century ago. These guns got their name from Carron, a small town in Scotland, where they were cast. They were made of cast iron, and in making them the workmen were naturally exposed to sparks from the molten metal, flying up as it was poured from the melting pot into the mould in which the gun was cast. The common remedy which the men employed was a mixture of linseed oil and lime-water, and this used to be known under the name of carron oil, which is very much the same as the linimentum calcis of the Pharmacopœia. I am inclined to think that the mixture with the linseed oil is even better than the mixture with the olive oil, and this is sometimes employed still as a remedy for burns or in small-pox where there is considerable irritation of the skin or where the epidermis from any cause is removed, and where the dermis thus denuded is exposed to considerable irritation. Lime-water is also frequently mixed with milk in order to prevent it from falling down in heavy curds in the stomach, especially in cases where patients are put entirely upon a milk diet. You will notice in the wards that sometimes one gives lime-water and sometimes one gives soda-water along with the milk in cases of typhoid fever. The object in both cases is the same: you wish to make the milk fall in small curds and so be easily digested; but if there is any tendency to diarrhœa, as there generally is in typhoid, the lime-water is preferable. If you find, as sometimes is the case, that there is a tendency to constipation, then soda-water is preferable. One objection to soda-water is that the carbonic acid which is given off from it, although useful in one respect, viz., that it keeps the fine curds further apart from one another, and thus renders them more easily digested, sometimes gives rise to very uncomfortable flatus. In a case of this sort, if there is still a tendency to constipation, you may employ simply water rendered slightly alkaline by means of bicarbonate of soda without using the aërated water which is generally employed.

Alkaline Salts of Vegetable Acids.—The salts of these bases with vegetable acids, especially acetic, tartaric, and citric acids, are useful remedies. These salts of ammonia are converted into urea in the body, and are excreted as such, but the acetate of ammonia is an important remedy in all febrile disease, and, to a smaller extent, the citrate also. The acetate is one of the oldest of our drugs, and is one which has held its place for centuries. It has the effect of increasing diaphoresis and of acting as a slight antipyretic. It has not such a power to depress the temperature as some of the newer drugs, but for that very reason it is sometimes safer, and so acetate of ammonia or citrate of ammonia is very largely employed either alone or in combination with spirit of nitrous ether as an antipyretic. Acetate of ammonia acts chiefly on the skin as a diaphoretic, acetate of potash rather on the kidneys as a diuretic. Acetate of potash is used as a diuretic, more especially in cases of chronic kidney disease, where it is frequently combined with acetate of iron. The acetates of the other alkalies are very sparingly used. Tartrate of potash is often used in place of the acetate as a diuretic. The acid tartrate of potash has a double action: in small quantities it is absorbed and acts as a diuretic and as an indirect antacid, rendering the urine alkaline; but in large doses it has not this effect, and then acts as a hydragogue cathartic. It is generally employed in conjunction with some vegetable cathartic which stimulates peristaltic movements of the bowels; so that the large fluid excretion produced by the acid tartrate of potash may be quickly evacuated, and may not be re-absorbed. In the form of compound jalap powder the acid tartrate of potash is much employed, and you will remember that it forms also an ingredient in the very common purgative sulphur and treacle as it used to be called, or confectio sulphuris as it is termed in the present Pharmacopœia.

NEUTRAL SALTS.—When you come to deal with the compounds of these bases with inorganic acids, you have something quite different from either the base or the acid. The neutral salts have an action of their own, different from that of their components.

Chlorides.—Chloride of ammonium is a drug which is largely employed, but its *modus operandi* is still obscure. It is sometimes given in large doses, 20 or 30 grains at a time, for abscess of the liver. You will find different statements in regard to its effect in this condition, and you can hardly expect that chloride of ammonium would cause a large abscess to disappear from the liver; but in cases of commencing abscess of the liver, where you are quite certain that there is hepatic congestion, and where there may even be more than this, where you have a very strong suspicion that an abscess has formed, chloride of ammonium in large doses, especially if combined with rest in bed and a milk diet, has really sometimes quite marvellous effects. Chloride of ammonium is also a useful remedy in cases of neuralgia and in myalgia. In sciatica and other neuralgias, and in the very common and troublesome form of myalgia known as lumbago, 10 or 20-grain doses of this drug are frequently very efficacious. It is a useful remedy for gout, and sometimes you will find that by its administration the deep depression of spirits that frequently occurs in gouty people may disappear. It has, however, a most disagreeable urinary taste, which is rather hard to cover, and many people object very strongly to it. The best way of disguising it, I think, is by the liquid extract of liquorice or else by the elixir of saccharine, which, I think, best covers its taste. Five drops of the elixir added to about 10 grains of chloride of ammonium is, perhaps, the best way of administering it, although many people do not dislike the mixture with liquorice. Chloride of sodium is naturally a very important remedy, because it is a most important article of food. There are a number of people who will not drink; they are not thirsty, they say, and the consequence is, their urine becomes excessively concentrated, so that without the presence of any abnormal constituent you may find it running up to 1,030, whereas it ought to be only 1,022.

You advise them to drink, but your advice is of no sort of use. However, you can sometimes effect your purpose by telling them that they had better eat more salt with their food, and the natural consequence of this is that they drink more water afterwards. There is a story about a physician whom I know which is so good that I think I had better tell it you now, lest I forget it later. He was consulted one day by a patient who had smoked to excess. This patient had consulted many other doctors, and they all said, "You smoke far too much; you must stop smoking." This last physician, who lives in Dublin, said, "Oh dear, no, my dear sir, there is no sort of necessity for your stopping smoking at all. I don't want to interfere with your smoking; smoke as much as you like and any tobacco you like, but I want you to smoke a particular kind of pipe. You must not smoke cigarettes nor cigars, nor short pipes of any kind, neither briar-root nor meerschaum, but you must invariably smoke a long churchwarden pipe." The patient was delighted. He thought the doctor was the first sensible man he had ever consulted, and felt sure that he thoroughly understood his case. He went away, and was not seen again for nearly a year, when he came back again and said, "Oh, doctor, I am ever so much better; in fact, I am perfectly well now. But, do you know, I found I couldn't smoke a long churchwarden in the street or when I was taking a walk in the country; in fact, the only time I could smoke at all was at night." "Precisely," said the doctor. He had gained his object without interfering at all with what the patient thought was his necessary occupation of smoking a pipe. In the same way that this doctor got round the patient who smoked too much you can sometimes get round patients who drink too little water. If you advise them to drink more water they say, "Oh, doctor, but I cannot;" but if you tell them to take more salt with their food, they will do so and drink more water afterwards, because it will make them thirsty. In this way they flush out their tissues, and improve very greatly.

Chloride of calcium has an action of very great importance. I showed you the effect of calcium upon the coagulation of the blood. and you noticed that when calcium was added to the blood which was previously uncoagulable not only did a coagulum form, but it became a solid mass, so that I was able to hold the vessel upside down without its dropping out. This is a property of very great importance in many cases. Supposing any of you are surgeons and are going to perform an operation on a patient in whom you know there is a tendency to bleeding, your natural idea will be to give him solution of calcium for some time beforehand, and thus increase the coagulability of the blood. Where bleeding has already occurred, as, for example, in bleeding from the stomach or from the bowels in cases of ulceration, you may give chloride of calcium. It frequently happens that you are unable to give it by the mouth, because you cannot run the risk of exciting vomiting in such cases, and in ulcer of the stomach, if you are feeding the patient entirely by the rectum, you may add chloride of calcium to the enemata. In some cases of typhoid fever, too, I believe that the lime-water, which is here commonly used in order to increase the digestibility of the milk, has another action in tending to lessen the chances of hæmorrhage from the bowel; and for that reason also I am inclined to prefer lime-water to soda-water for admixture with milk in typhoid fever. In cases where hæmorrhage has already occurred, you may give lime-water more freely; and sometimes when you wish to give lime along with the milk without diluting the milk too much you may use the liquor calcis saccharatus in place of the ordinary liquor calcis. The admixture of sugar renders the lime much more soluble, and in consequence of this you can get a solution nearly fourteen times as strong as ordinary lime-water, which may be mixed with the milk without diluting it unduly.

Sulphates.—The sulphates of these bases with which we are chiefly concerned are sulphates of soda and magnesia. Both of those are powerful purgatives, and may be given to open the bowels, either as a simple laxative in constipation, or in cases where we wish to clear out the bowel more thoroughly, especially after the administration of a mercurial pill. They are used very freely indeed in the form of mineral waters. The sulphates of magnesia and of soda form the active ingredients in most of the mineral waters so much in vogue at the present day. Another way of giving them is in the effervescing form, in which they are more agreeable to take, and I think I have already mentioned that it is advisable to make your patient get up before, or immediately after, he takes the mineral water, as otherwise it may be absorbed and have very little purgative action. Now in certain cases where you wish to get a large quantity of fluid evacuated from the body, as in cases of extreme dropsy and heart disease, the sulphate of magnesia must be given in a different way from the usual one. When you simply wish to clear out the intestines, the best way to give the sulphate of magnesia or soda is with a *large* quantity of water, and especially of hot water, drunk immediately after rising. This generally causes a free evacuation after breakfast without more bother, but *small* quantities of water are apt to cause trouble to the patient, so that he gets a good deal of boborygmi, and sometimes of griping, during the day without any good evacuation. But in cases where there is a large quantity of fluid in the body, ready to come away if you can only get it away, the plan is to give sulphate of magnesia in as little hot water as will dissolve it—half an ounce of sulphate of magnesia in a small quantity of water—and keep the patient on as dry a diet for a day previously as you possibly can. When given in this way it produces a free evacuation of watery fluid from the intestines, the water having been absorbed from the tissues or serous cavities, and in this way you get rid to a large extent of the dropsy previously present.

Phosphates.—Phosphate of soda has an action very much like sulphate of soda. Its advantage is that it has very little taste, and may be easily given, especially to children. It may be administered in weak chicken-tea or beef-tea instead of salt, and they hardly notice the taste of it. It may also be given in the effervescing form, and is a favourite remedy with some gouty patients, who prefer it to the sulphates either of soda or of magnesia.

Phosphate of lime is also an important drug, but it is not used to anything like the extent that the others are. The cases in which it is useful are those of children who are imperfectly nourished, in whom the addition of phosphate of lime to their food sometimes helps their nutrition very considerably, and it may be given also to women who are suckling, and in whom the teeth are decaying. Giving them phosphates tends to prevent the decay of the teeth, as I mentioned before (p. 370).

Nitrates.—The only nitrate that is of much importance is that of potash. This seems to undergo reduction in the intestine and to be converted partly into nitrite, when, like the other nitrites, it tends to dilate the vessels, lower the blood pressure, and act as a diuretic (p. 129).

Nitrites.—Nitrite of soda has also been used by itself to lower the blood pressure in cases of angina pectoris. I should mention also, in speaking of this disease, that calcium and barium have a tendency to strengthen the heart and to prolong the systole. Potash, on the other hand, has a tendency to shorten the systole and make it more feeble. Potash salts are, therefore, looked upon as depressent to the heart, whereas calcium and barium salts are tonic to the heart. You will frequently find, however, that patients are very much afraid of potash salts on account of its having become generally known that potash has a depressent action upon the heart, and yet those very patients who are so much afraid of half a grain of potassium in the form of iodide of potassium will take a large quantity of beef-tea, and in that beef-tea there are far more potash salts than in the medicine to which they object. In the one case they regard it as a stimulant, and in the other as a depressant. Sometimes, when you get a patient who unreasonably objects to the potash salts, you may tell him that the objection is completely unfounded, and in the beef-tea which he is taking as a stimulant he is getting a larger quantity of potash salts than in the medicine he does not like to take.

On account of the effect of the calcium and barium salts upon the heart, they are now a good deal used in the form of baths and of waters in cases of heart disease, and in these cases we usually have the combined effect of graduated bodily movements along with the baths and along with drinking the waters.

Alkalies.—I shall just enumerate again shortly the characteristics of the bases. Ammonium is a powerful nervine stimulant. Sodium is more or less indifferent, as you would well imagine from the large amount of soda in the body; and because the small quantity of soda that is added to the body in any medicine that you give is but slight, it alters very little the proportion of sodium in the body. Potash acts as an alterative, especially in cases of gout and rheumatism, and has to a certain extent the effect of weakening the heart, weakening the muscles, lowering the blood pressure, and acting as a diuretic. But the weakening effect upon the heart and muscles is only perceptible when large doses are employed, and rarely comes into consideration from the ordinary medicinal doses.

Lithia is employed chiefly in cases of gout, in order to render the deposits of urates more soluble. The urate of soda forms an insoluble salt; the urate of potash is more soluble; the urate of lithia is more soluble still, and so lithia is frequently preferred to potash in the treatment of gout, although here, as you will find if you read the recent researches of Dr. Haig, there seems to be a good deal of doubt as to whether lithia really does expel uric acid from the body so much as potash.

Alkaline Earths.—Magnesia is chiefly serviceable, first of all, on account of its being sparingly soluble, so that if you give it as an antacid only so much of it is used as is required to neutralise the acid in the stomach, and you cannot render the stomach very much too alkaline by it. Its chief importance consists in its salts and in the ease with which some of the magnesia is converted into salts in the stomach and intestines, and these have always a laxative action.

Calcium, on the other hand, instead of being a laxative, is an astringent throughout, an astringent to the skin, to the mucous membranes, and to the intestine. It tends to increase the coagulability of the blood, to harden the tissues, and to render the heart more powerful and the blood pressure higher. You will remember that I told you that one of the secret remedies in cases of calculus of the bladder consisted simply of pounded egg-shells—carbonate of lime.

Zinc Group.—The next group to which we come contains aluminium, zinc, copper, and silver. Now all of these have a powerful astringent action. When mixed with albumin, they form a solid coagulum; when applied to the surface of a sore, they coagulate the albumin upon the ulcer, and they thus form a protective coating under which healing goes on. At the same time, this coating has a tendency to contract, so as to exert a little gentle pressure upon the healing surface. This surface is, therefore, at the same time protected from external violence, and has a little pressure made constantly, but gently, upon it, which tends to prevent the granulations becoming exuberant. Healing, therefore, takes place more quickly and more thoroughly under the protective coating afforded by the coagulated albumin after the application of alum, zinc, copper, or silver. Alum is the least powerful of these, silver the most powerful. When applied to a mucous membrane the same thing takes place as on a wound: the mucous membrane itself tends to become harder, and the secretion from it tends to become less. Alum, zinc, and copper are, therefore, all used more or less as injections in cases of inflammation of the mucous membranes. They may be employed, for example, in the case of the ear, the vagina, or the urethra, and we have in our Hospital Pharmacopœia various lotions for injection both into the vagina and into the urethra, containing alum, zinc, and copper.* We had one of sulphate of zinc and sulphate of aluminium, which is very much used indeed. The sulphate of zinc used is generally in the proportion of 1 or 2 grains to the ounce, and the aluminium in 5, 10, or more

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* (1) Lotio aluminis :—
Pulv. aluminis, grs. iv, viij, or xvi.
Aquæ destillatæ, ad ℥i.
(2) Lotio argenti nitratis :—
Argenti nitratis, gr. i—xv.
Aq. destillatæ, ad ℥i.
(3) Lotio cupri sulphatis :—
Cupri sulphatis, gr. ij.
Aq. destillatæ, ad ℥i.
(4) Lotio zinci sulphatis, gr. ij or iv.
Aq. destillatæ, ad ℥i.

grains to the ounce. A mixed solution of sulphate of zinc 1 grain and sulphate of aluminium 10 grains to the ounce forms a very powerful and useful astringent injection. Alum is used largely as a gargle, especially in cases of sore throat. Zinc may be employed also for the same purpose, but is less used, and sulphate of copper still less, because of the disagreeable taste that both have—a taste which is not only disagreeable, but very persistent. Sulphate of copper and nitrate of silver are often used in substance in order to cauterise the fauces where there is ulceration, and sometimes where there is no ulceration, but where the uvula is long, dependent, and œdematous. This is touched with a little nitrate of silver, which causes it to contract and lessens the irritation, tickling and cough, or retching which the long uvula produces when it drops down upon the back of the tongue. Internally all these three are powerful emetics. Sulphate of zinc is frequently used internally in 20 or 30-grain doses, sulphate of copper in 10-grain doses, as an emetic. Their advantage is that they cause little nausea and rapid vomiting, so that you prefer them to a tartar emetic in cases of poisoning where you wish to have the stomach rapidly evacuated. The reason why 10-grain doses of sulphate of copper are employed, whereas you use 20 grains of sulphate of zinc, is that the sulphate of copper if retained is more likely to cause irritation and inflammation of the stomach than the zinc would be.

Nitrate of Silver.—Nitrate of silver when solid also acts as a powerful emetic, but it is much more irritant than either of the other two, and so is almost never given as an emetic. Now it is very likely that you may wish to employ nitrate of silver as a caustic to the back of the throat, and there are one or two precautions that are requisite. It is very probable that you may have to use it in the case of children. Children are sometimes very difficult to keep quiet, and in their struggles you may get a bit of the caustic broken off. The stick of caustic is usually clasped in a split tube, the two ends of which are held back by a ring, and occasionally this piece of caustic is allowed to project a long way. Now, when you are going to apply it to the throat, the first thing you have to do is to see that it does not project far, because if it does there is a great risk that a piece may be broken off in the child's throat, and very likely swallowed. What you ought to do is, take care that your caustic projects only just as far beyond the caustic holder as will enable you to cauterise the child's throat thoroughly without a bit breaking off. But supposing, in spite of all your precautions, that a bit breaks off, and the child swallows it, what are you to do? Well, probably the best thing you could do would be to give the child a large quantity of such a thing as oatmeal porridge or gruel. The common plan is to give the child a quantity of common salt, and one would imagine that this would render the nitrate of silver quite innocuous, because the salt will convert it into insoluble chloride of silver. This, however, is not altogether true, because there is a case on record where the doctor followed this plan, and yet the child afterwards died from inflammation of the stomach. A good big bit of caustic probably had broken off in that case, and although by using salt a coating of chloride formed over the surface of the stick of nitrate of silver at first, yet after awhile this got rubbed off by the movements of the stomach, and so the bit of nitrate of silver went all over the stomach, cauterising it as it went, and leading to inflammation, which brought about the death of the child.

First of all, then, avoid the occurrence of any such thing, but if a bit should unfortunately get broken off, or if somebody else, not knowing this, should have met with this accident, and you are called in to help, give the child a lot of gruel or oatmeal porridge, which will tend to cover the caustic up, and then it may either be evacuated by using an emetic, or it will become gradually dissolved, and, instead of remaining as a solid mass, it will be converted into chloride in small flakes, so that there will be no risk of inflammation of the stomach setting in. Now, what occurs in the stomach in such cases occurs also in the throat to a less extent every time that you apply nitrate of silver; that is to say, you get a little irritation and inflammation over the spot where it has been applied, and thus there is a most persistent disagreeable taste. But this you can get rid of by letting the patient gargle the throat with a solution of chloride of sodium—common salt. By this means you get on the surface a thin coagulum of chloride of silver. which, being absolutely insoluble, has no taste.

Astringents.—Now all these drugs have also an astringent action upon the mucous membrane of the intestinal tube, and sulphate of zinc and sulphate of copper may be used also in cases of obstinate chronic diarrhœa. I should mention that nitrate of silver is sometimes used as a sedative to the stomach. In small doses it appears to lessen irritation, although in large doses it is a powerful irritant, and the usual dose of the nitrate of silver is quite small. It is best to give just about $\frac{1}{10}$th of a grain of the nitrate or half a grain of the oxide of silver. One precaution is to be observed: oxide of silver is frequently given for vomiting, and, if you do not think of it, you are likely to combine with it another remedy that is useful for vomiting, viz., creosote. So that quite a natural thing would be to make up a pill with oxide of silver and creosote, but if you do this creosote is likely to become oxidised at the expense of the oxygen in the oxide of silver, and the mixture would then undergo spontaneous combustion. Nitrate of silver has been sometimes used as an application in chronic dysentery and diarrhœa in the form of enema. It has been found in cases of dysentery that when a weak solution of nitrate of silver has been introduced into the bowel in the form of an enema, and yet the patient died, post-mortem examination has shown that the dysenteric ulcers had healed as far up as the enemata had penetrated; so that it is natural to conclude that if you were to give a very large enema of a weak solution of nitrate of silver under very low pressure, and repeat it a good many times, the whole of the dysenteric ulcers might be healed. It is worth while to remember this, because some cases of chronic diarrhœa and dysentery are most difficult and troublesome to cure.

After absorption the sulphates of zinc, of copper, and nitrate of silver all act as nervine tonics, and they are all employed in cases of chorea and various other nervous diseases.

MERCURY.—The next drug that we come to is mercury, which has a very peculiar action indeed. It is found that when mercury has been given up to a certain extent it appears to displace lime in the body, and in animals poisoned by mercury the kidneys are very often affected; and in the tubules little hard concretions are found, which do not consist of mercury, as one would expect, but of lime. Mercury is said to be an alterative. In solution it is perhaps one of the most powerful of all disinfectants that we have, and the two forms in which it is generally used as a disinfectant are perchloride and periodide. Perchloride in the strength of 1 in 2,000 or 1 in 1,000 is very frequently employed to swab out the throat in cases of septic sore throat or in diphtheria; and in cases where you cannot get the solution far enough down by means of a brush you may manage it by means of a spray-producer. Mercury may be absorbed from any part of the body, and in almost any proportion. It is one of the drugs which, when applied externally, are absorbed through the skin, and one common way of inducing mercurial action is to rub mercurial ointment over a large surface of the skin. Another way of employing it is to make the patient sit on a cane-bottomed chair and put underneath him a small vessel in which calomel is contained. Underneath this vessel place a spirit lamp, and the calomel, being volatile, is converted into vapour, which settles upon the skin of the patient. It appears to combine with the sebaceous matter of the skin, and is gradually absorbed, so that calomel fumigations and inunction are both favourite methods of inducing mercurial action.

When taken into the stomach the soluble preparations of mercury act as very powerful irritants. A celebrated French chemist was one day lecturing on preparations of mercury, and he had close to his hand a tumbler of water and a beaker containing a solution of perchloride of mercury. While lecturing he became thirsty, and without looking he put out his hand, took up the wrong glass, and drank off the solution of perchloride of mercury. He at once told the class what he had done, sent for several eggs, and drank them off one after the other. The result was that the albumin of the eggs formed an albuminoid of mercury with the perchloride in the stomach; this was vomited, and the chemist sustained no damage from the accident. This is the proper treatment to be employed in cases of poisoning by perchloride of mercury or by other soluble mercurial salts; and poisoning by these mercurial salts is not at all unlikely to occur, because they are much used as disinfectants. I may say that the same treatment holds with other soluble metallic compounds. For example, if it had been chloride of zinc or a strong solution of sulphate of copper, the same treatment would have held, and raw eggs are about the best antidote that you can employ in such cases.

Mercury, in the form either of grey powder, of blue pill, or of calomel, has a purgative action, but its action as a simple purgative is of no great importance. Its action, however, as a cholagogue purgative is very important indeed. The exact *modus operandi* of the salts of mercury upon the liver has not yet been satisfactorily determined, but in all probability these preparations, blue pill, calomel, and grey powder, tend to act upon the upper part of the intestine, and especially the duodenum, sweeping the bile quickly out and so preventing its re-absorption. If you give any of them without giving a saline purgative in the morning, "to carry them off," as it is termed, they may make your patient very uncomfortable; so, as a general rule, when you have given any mercurial preparations overnight, you give a saline purgative in the morning, just as the patient rises, to carry them off.

Syphilis.—The chief use of mercury internally is, however, as a remedy in syphilis. It seems to have the power of destroying the syphilitic poison, whether it be the bacilli that give rise to syphilis or the products of their life which act as toxins. At any rate, it is found that mercury is *the* remedy for syphilis. It is generally employed in the primary stage, that is to say when a sore occurs at the point where the virus has been inoculated, or in the secondary stage, a few weeks afterwards, when virus has been absorbed into the system, and the mucous membranes and skin have become affected. It is given, as I have before remarked, in the third, or tertiary, stage also in cases where it has not been previously administered in the primary or secondary stage. But in the tertiary stage, if mercury has been previously administered, we find that the iodide of potassium is sufficient, without any further administration of mercury.

Mercury seems also to have the power of breaking up fibrinous deposits. This has been actually seen in cases of fibrinous deposits in the eye where mercury has been given, and under the influence of the drug the deposit has visibly melted away. Judging from its effect in the eye, it is likely to act on fibrinous deposits elsewhere, and it has been given in cases where they could not be seen, as, for example, in cases of pleurisy with thickened adhesions and in cases of pericarditis. It is very hard to say in cases of pericarditis whether the drug you are giving is of any use at all, but there is no doubt that occasionally it seems to be beneficial.

In cases of infantile syphilis you frequently get very good results from the administration of mercury, but here it is usually given by inunction. You take a bit of blue ointment about the size of a hazel-nut, and put it upon a binder, which is then swathed round the body of the child, so that the movements of respiration gradually cause the blue ointment to be rubbed over a good portion of the child's abdomen, and thus the mercury becomes absorbed.

Now it is sometimes advisable to push the drug until the signs of so-called mercurial action appear, and until these signs of its physiological action appear you may not derive much good from the mercury. The first sign of mercurial action is a slight disagreeable taste, which the patient often describes as a "coppery" taste, in the mouth. Then the teeth become, as the patient terms it, "sticky:" they feel as if they were a little longer than usual, and as if they stuck together when he tries to separate them. Next, the teeth become a little tender and feel a little sore when they are brought together, the gums are a little tender, the breath acquires a foul odour, the saliva becomes somewhat increased, and the gums show a little red line around their edges just at the junction of the gums and teeth. When these signs appear, you lessen the dose or discontinue the remedy altogether. In the old days it was not so. The idea then was that the more the patient was salivated the better he would be, and so they went on pushing mercury until the salivary glands became inflamed and swelled, and until the saliva poured in pints from the mouth. It was sometimes carried so far that the patient would pass from the mouth eleven pints of saliva in the course of the day. If the gums and teeth become too painful, you may lessen the local irritation in the mouth by giving a gargle containing 10 grains of chlorate of potash to an ounce of water or rose-water.

When mercury is taken in other ways, you sometimes get diseases caused by its toxic action. The form in which you are most likely to meet this effect in St. Bartholomew's Hospital is in that of mercurial tremors, because in its neighbourhood, at Hatton Garden, there are men who make thermometers and barometers. In doing so they have to boil the mercury in them, and from inhalation of the vapour they get mercurial tremors. The treatment here is to administer iodide of potassium, which withdraws the mercury in a soluble form from the tissues into the blood, and then it is excreted by the emunctories, chiefly by the kidneys. Another form is mercurial cachexia, in which the patients get wan and ill without any apparent cause, and they suffer dreadfully from pains in their joints at changes of weather. There is another form in which mercurial poisoning occurs, but fortunately very rarely. Two dreadful cases occurred in this Hospital. One of the former lecturers on chemistry was much interested in certain mercurial compounds. He set his assistants to make mercuric ethide, and one of the men who were engaged in making this compound got the symptoms of well-marked mercurialism, with enlarged and swollen joints, great headache, etc., and died in three months. The other became insane, and died at the end of a year. It appeared as if the mercurial vapour had somehow got hold of his cerebral centres and upset their functions. Mercury does not seem to do this except when it is combined with some alcoholic compounds, which direct its action towards the nerve centres and alter their functions.

LEAD.—The next drug we come to is lead. The action of lead differs from that of most of the other metals of which we have been talking in this respect: that when applied to a sore spot, although the lead forms with the albuminoids a hard compound and has an astringent action just like that exerted by silver, zinc, or copper, yet this compound has no irritant action upon the nervous part, but, on the contrary, rather a sedative action. So lead is at the same time an astringent and sedative, whereas the other metals are astringent and stimulant. On account of this sedative action of lead, it has been a good deal used as an application to the eye in cases of catarrh of the conjunctiva or inflammation of the conjunctiva. The great objection to lead in such cases as that is that if there be any ulceration of the cornea, the albuminoid of lead which is formed there may give rise to an opacity. Therefore you must be careful in applying lead to an eye where there is ulceration of the cornea, but where there is no ulceration salts of lead are exceedingly sedative and soothing to the patient. In the same way, salts of lead lessen the irritation in other mucous membranes at the same time as they act as astringents. To the surface of the body lead salts act as powerful sedatives, and may be exceedingly useful either in the form of a lotion or of an ointment in cases of chronic skin disease, as, for example, eczema. In the stomach they have but little action, but upon the bowels they act as powerful sedatives, causing great constipation. In large doses, soluble salts of lead, such as the acetate of lead, act first of all as irritants and afterwards as astringents, so that violent vomiting results; but instead of this being succeeded by purging, as it usually is in the case of other metallic salts, it is succeeded by obstinate constipation, with much colicky pain in the abdomen.

LECTURE 33.

Lead, *continued*—Plumbism and its treatment—Nitrogen group—Phosphorus — Antimony — Arsenic — Local action — General action — Arsenic-eaters—Bismuth—Local sedative—Iron— Manganese—Benzene series—Phenol—Carbolic acid poisoning—Diagnosis—Treatment—Salicylic acid—Benzoic acid—Quinine—Action of aromatic compounds on the skin—Rashes.

GENTLEMEN,

When taken in small quantities for a length of time, lead usually produces very marked symptoms, which are due to its effect in causing irritation and contraction of involuntary muscular fibre. Under the action of lead, contractions of the colon occur which lead to constipation and to severe pain. At the same time the pulse is usually tense from contraction of the arterioles. The symptoms produced by lead have been classified into two general groups, viz., lead colic and lead palsy. The chief symptom of lead colic is intense pain of a griping character, generally situated about the umbilicus. This pain is not increased, but is rather diminished, by gentle, firm pressure. It is usually accompanied by obstinate constipation. It is sometimes difficult to know what the cause of such pain is, but the distinctive character which usually allows you to trace this form of colic to its cause is the blue line which appears around the gums in cases of lead poisoning. You will find just around the base of the incisor teeth a bluish line. This line is due to the deposition of black sulphide of lead beneath the mucous membrane, and the black sulphide of lead shining through the mucous membrane assumes a bluish colour, just as the black gunpowder with which tattooing is usually performed has a blue colour when seen through the skin.

Lead palsy is usually observed in the extensors of the wrist, but frequently associated with it, and sometimes preceding it, we get lead cramps, which are usually found in the flexors. The palsy shows itself in the wrist dropping, from the extensors being unable to raise it. It sometimes is so complete that the extensor tendons which pass over the back of the hand, and which tend to a certain extent to keep the bones in position, become quite loose, so that the bones of the wrist are apt to be readily dislocated. In both lead palsy and lead colic the treatment is the same, viz., firstly, elimination of the lead out of the tissues into the blood, and secondly elimination from the blood out of the body altogether. For the purpose of eliminating it from the tissues into the blood we use iodide of potassium in regular doses, say 5 to 10 grains three times a day. Once it has got into the blood, it is eliminated by various organs, first of all by the mucous membrane of the intestine, and probably it is during the course of elimination that it gives rise to these colicky pains of which I have spoken. It is eliminated, secondly, by the kidneys and, thirdly, by the skin. The old methods of treatment of lead poisoning were based upon the attempt to prevent re-absorption. For example, sulphur was given in the form of baths to render the lead, which had been excreted by the skin, insoluble and prevent re-absorption from the skin. Sulphur was given internally in order to produce sulphide of lead in the intestine and render the lead insoluble and prevent its re-absorption. Another plan was to give castor oil regularly day by day with the purpose of sweeping the lead out of the intestine, but the plan that we most generally follow now is the regular administration of a soluble sulphate, such as sulphate of magnesia, in combination with iodide of potassium. For example, the stock treatment that we adopt in the out-patient department here in cases of lead poisoning is to give the iodide of potassium three times a day and a draught containing sulphate of magnesia and sulphuric acid three times a day, with an hour or a couple of hours between the two draughts. The iodide of potassium brings the lead out of the tissues into the blood, and causes its elimination into the intestinal canal. Then in that canal the sulphate first renders the lead insoluble, and then, by virtue of its purgative action, sweeps it out.

Lead is very apt to accumulate even when taken in very minute doses, and so you require to be careful to look into all the sources of possible intoxication when you are called upon to deal with a case of lead poisoning. Most of you know that soft water dissolves lead, and a carbonate is formed which is soluble in excess of carbonic acid. Usually soft water dissolves lead pipes very readily, and people who are served with a supply of soft water are apt to suffer from lead poisoning, the lead being dissolved either from the pipes through which the water passes or from the tanks in which it is stored. If the water contains a quantity of earthy salts, poisoning is not so likely to take place, because amongst the salts phosphates, chlorides, or sulphates generally occur, and the phosphate, chloride, or sulphate of lead becomes deposited as an insoluble precipitate upon the lead pipe, and so the water after the first few days no longer comes into contact with the metallic lead in the pipe or tank. There are very many other sources, which would take too long to go into now. The main points which you must remember about lead are the tendency that it has (1) to cause lead colic with constipation and griping pains, (2) to cause lead paralysis, and (3) that in order to remove these symptoms you give iodide of potassium and a soluble sulphate.

Nitrogen Group.—We pass now to a very important and large group: nitrogen, phosphorus, arsenic, antimony, and bismuth. I mentioned to you, when speaking of alteratives, that the other substances belonging to this group might take the place of nitrogen in the animal economy, and so alter tissue change. I discussed all the symptoms of phosphorus poisoning at such length that I need not go into them again now. You remember I said that phosphorus produces first of all symptoms of gastro-enteritis, which usually subside, and are succeeded after an interval of a day or two by a recurrence of the gastric symptoms, to which are added disorder of the liver, nervous system, and heart, the patient dying comatose, with a considerable amount of jaundice and frequently convulsions, and that these symptoms are due to fatty degeneration taking place in all the organs of the body. Now, arsenic and antimony tend to cause local irritation like phosphorus, and, like it, they tend, after their absorption, to cause fatty degeneration of the organs.

Antimony.—When applied externally, antimony tends to act as a pretty powerful irritant, but it does not cause general irritation. Its action is localised at the mouth of the sweat or sebaceous glands, and there it gives rise to little pustules. Antimony was formerly very much used as a pustulant in cases of phthisis, and is still sometimes employed in order to cause chronic irritation for a length of time in bronchitis, and sometimes as a counter-irritant to the head in cases of inflammation of the meninges.

In small or moderate doses, antimony, when taken internally, acts as a powerful emetic. It causes first of all a great deal of nausea, and then produces violent vomiting. Along with the vomiting, you find that the secretion from the salivary glands is increased, and also the secretion from the sudoriparous glands, so that the patient sweats a good deal. This power of antimony to cause sweat is utilised in order to produce diaphoresis, and antimony is, therefore, employed as an emetic, as a nauseant, and as a diaphoretic. It also gives rise to increased secretion from the bronchial mucous membrane, and as the secretion becomes at the same time more fluid, and is, therefore, more easily brought up, antimony is used as an expectorant. It may be given in the form of a pill, usually about $\frac{1}{8}$th of a grain or up to $\frac{1}{12}$th of a grain, but it is more usually employed in the form of antimonial wine. Antimonial wine is one of the very oldest remedies we possess, and it was at one time made up by putting wine into a cup made of antimony and leaving it to stand. After awhile the wine, which contains acid tartrate of potash, dissolved a little antimony, forming with it tartarated antimony, and this is still the preparation that we generally employ. Tartarated antimony is simply bitartrate of potash, in which the place of hydrogen is taken by the radicle (SbO*). The dose of antimonial wine is about half a wine-

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* Tartaric acid, $C_4H_6O_6$.
Acid tartrate of potash, $C_4H_5KO_6$.
Tartar emetic, $C_4H_4K(SbO)O_6$.

glassful, that is to say, about an ounce, containing 2 grains of tartarated antimony. This is a pretty large dose, and is almost certain to cause violent emesis.

Arsenic.—Arsenic is not much employed externally in ordinary medical practice, but it is largely used in quack practice, because arsenic forms the basis of the so-called quack cancer pastes. Now, one is inclined to ridicule these, but I have known of one case, at least, in which a quack succeeded after all the best surgeons who had been called in consultation failed. This was simply an illustration of the old proverb, "Fools rush in where angels fear to tread." This man not having enough knowledge, applied a paste, whereas those who had more knowledge were afraid to venture upon an operation. It was the case of a man who had cancer in the orbit, and this quack applied a paste containing arsenic, with the result that the eye sloughed out, and the man got well, but the amount of suffering that the poor patient endured must have been simply awful. The views that used to be held in regard to this treatment were that the paste should not be applied over a large surface at a time, and that the proportion of arsenic in it should always be large. If the arsenic were present in the paste in large proportion, it caused a slough to form almost at once, so that the absorption of the arsenic was prevented, but, if the proportion were small, a good deal of it was absorbed, and general symptoms of poisoning might be produced.

Arsenic has also an irritant action upon the stomach, and, in cases of poisoning, produces violent vomiting and purging. The purging in cases of arsenical poisoning is very like that which occurs in cholera, the motions being almost free from bile and exceedingly watery, so that certain cases of arsenical poisoning have been supposed to be cholera, and cases of cholera at the beginning of an epidemic have been frequently suspected to be cases of poisoning by arsenic. Very minute doses of arsenic have an opposite effect to that of large doses. Instead of causing loss of appetite, nausea, and vomiting, they produce great appetite, and a very small dose acts as a sedative to the intestinal tube, so that, when given before meals, it tends to check that form of diarrhœa which occurs when the intestinal canal is exceedingly irritable, and the mere introduction of food into the stomach is at once followed by a call to go to the closet. Half a drop or a drop of Fowler's solution of arsenic, that is to say, of liquor arsenicalis, given before meals, often answers exceedingly well in such cases.

When absorbed arsenic acts upon the body generally, and tends more especially to act upon the nervous system. When you wish to get it absorbed and to secure its general action, it is necessary to give it in a different way entirely from what you do when you wish to obtain its local action. To get the local action of arsenic, you give it before meals, in order that it may find nothing which will prevent its acting upon the walls of the stomach and intestine; if you wish to get it absorbed, you give it immediately *after* meals, so that it shall have no local action on the stomach or intestine, but shall be mixed with the food and absorbed. It is given often for its general action upon the nervous system in cases of neuralgia, and an exceedingly good antineuralgic it is. It is given also in cases of chorea, and it is frequently employed as a general nervine tonic. It is not unfrequently given also as an alterative in cases of gout, and is very often employed in cases of skin disease. In diseases of the skin it is often of the very greatest service. How far this is due to its power of causing fatty degeneration in the lower strata of cells in the skin I cannot at present discuss. There is another disease in which it is useful, and in which you would hardly suspect its use, for you could not arrive at the fact except by empiricism, and that is ague. You will all meet with lots of cases of malaria, and, as a rule, malaria may be kept off to a certain extent in malarious districts by the prophylactic use either of quinine or of arsenic. Supposing, for example, some of you enter the Indian medical service, and you are sent with a lot of troops up to a malarious district, it may be worth while to give the soldiers under your care quinine or arsenic as a prophylactic measure before they actually get ill, because there seems to be little doubt that, by the administration of those drugs while the men are still well, you can keep them well to a great extent. After the disease has begun to appear in a definite form, quinine is best if the attacks are well marked, but in the so-called cases of masked malaria, when you do not get regular attacks, but various abnormal forms of malarial diarrhœa, neuralgia, etc., arsenic is sometimes better than quinine.

Arsenic-eaters.—The ordinary dose of arsenic for its local action is about half a minim of the liquor, which is a 1 per cent. solution. For its general action upon the body you begin with 3 to 5 minims, which may be increased gradually, sometimes up to 30 minims or more. Now, there is a curious point about the action of arsenic, and that is, that people may become habituated to it, so as to take enormous doses. In Styria the peasantry for a length of time have been in the habit of eating arsenic. A great deal of doubt has been thrown upon this statement, but now it is put beyond question that they do eat arsenic in quantities sufficient to poison people who are not accustomed to it. The object of eating it is twofold: it is said that it gives them greater strength and endurance, and that it renders the complexion much better, so the men eat it in order to get strength, and the women eat it in order to improve their appearance. There can be little doubt that it does improve the complexion. As I mentioned before, arsenic and all the substances belonging to this group tend to produce fatty degeneration; they lessen the combustion of tissues in the body, and if you can adjust the dose properly you may lessen the combustion of fat and tend to make it accumulate, apparently without causing any destruction of the albuminous tissues. You simply increase the fat without increasing the tissue change, so that arsenic may be given for the purpose of increasing the deposit of fat under the skin. It is rarely given by doctors for this purpose, but it is sometimes taken by people of their own accord. Arsenic and antimony are both used by coachmen for the purpose of making their horses' coat more glossy and sleek. Some of you may possibly remember what was called the "Balham Mystery," in which a man was murdered, and it was found that the antimony with which he was poisoned was kept in large quantity in the stable and used by the coachman for the purpose of making the horse's coat sleek, but antimony is not so often employed for this purpose as arsenic is. I have heard it stated that there was one doctor, who, if the story be true, was a disgrace to his profession, who was accustomed to give regularly to all little children under his charge small doses of arsenic. He thus converted them into regular little arsenic-eaters, and they looked fair, sleek, and well while they were under his care, but he always supplied his own medicine, so that the patients did not know what medicine they were taking, and if any of the parents became dissatisfied and took their children to some one else, the little arsenic-eaters at once began to fall off, and then the parents were obliged to take them back to the first doctor. Now, when people have got into the habit of eating arsenic, they are generally obliged to go on with it, because, if they leave it off, they find most disagreeable symptoms come on, and they get, indeed, some of the symptoms of arsenical poisoning, great pain in the abdomen, and sometimes they die when they try to give up the arsenic.

Bismuth.—Bismuth has a local sedative action in large doses, and in a soluble form it has an irritant action upon the stomach, just like arsenic and antimony, though not so powerful. In moderate doses bismuth acts in the same way as small doses of arsenic, so that, perhaps, about a drachm of the liquor bismuthi would have a similar action upon the stomach to about half a minim or a minim of liquor arsenicalis. Bismuth is sometimes applied externally as a local sedative in cases of skin disease, and it is very much used as a cosmetic. The oxychloride of bismuth is the preparation usually employed, because it is the finest powder. Of course people who are using bismuth as a cosmetic must avoid coming near any sulphuretted hydrogen gas, and it is said that some awkward occurrences have taken place in the Royal Institution. Some of the ladies who were sitting in the front row during chemical lectures became of a curious greenish colour when the lecturer was using sulphuretted hydrogen, which, acting upon the bismuth, turned it black, and gave a sort of greenish, bilious look to the face. The only thing to remember about the oxychloride of bismuth is that, being used as a cosmetic, manufacturers take a great deal of trouble to make the powder very fine, and probably this powder is more finely pulverised than any of the other preparations of bismuth. It may be employed internally as a remedy, either by the mouth or by the rectum, in cases where you wish to secure its local action in ulceration of the intestine. As a local sedative internally bismuth is very much used, both for the stomach and the intestine, and in cases of painful digestion we give it very much indeed, either where the pain seems simply to be due to functional disorder of the stomach, or where it is really due to ulceration, whether this be simple or malignant. The dose in which it is given is generally about 10 grains. Some physicians give it in very much larger doses, and it does not make very much difference whether you use the carbonate or the subnitrate, unless you happen to be giving, as you very often do, a bicarbonate along with the bismuth. If you do this you practically employ carbonate of bismuth, because the subnitrate of bismuth, when mixed with bicarbonate of soda, acts as an acid, and when the two are mixed together in largeish quantities in a bottle so much carbonic acid is formed that the cork is blown out, and sometimes if the cork has been put in firmly, and the bottle is a weak one, the bottle itself is burst. Of course after awhile the decomposition is complete, and after the carbonic acid is given off carbonate of bismuth, with nitrate of soda, remains. It may be given also in the form of liquor bismuthi et ammonii citratis (B. P.), half a drachm to a drachm being the usual dose. This may be employed along with bicarbonate of soda or carbonate of ammonia. We have in our Hospital Pharmacopœia* a draught which is much used; this consists of subnitrate of bismuth, bicarbonate of sodium, and chloroform water, mixed in the way I have warned you against. But in this case it does not matter, because this draught is made in large quantity, and the carbonic acid is allowed to escape. It is not made in a small bottle with the stopper kept in, so you get the double decomposition completed before the draught is actually dispensed.

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* Haustus Bismuthi :—
Bismuthi subnitratis, gr. x.
Sodii bicarbonatis, gr. x.
Aquæ chloroformi, ad ℥i.

It is always to be remembered that the sedative action of bismuth upon the stomach is accompanied by a sedative action upon the intestine, which is very useful indeed in some cases, but sometimes is objectionable, because if you have got irritation of the stomach and intestine together bismuth is very useful, but if you have irritation of the stomach while the intestine remains normal the bismuth may be injurious, as it gives rise to such a sedative action upon the intestine that obstinate constipation results. So in cases where you are giving bismuth you must always look out for the possibility of your patient suffering from a considerable amount of constipation, and you may prevent it to a great extent by giving some carbonate of magnesia, either as a powder or in solution, along with the bismuth.

Iron.—The next drug that we have to consider is one which is very largely used, and of which there are an immense number of preparations in the Pharmacopœia, but we may dismiss it shortly, because its actions are tolerably simple; the drug I refer to is iron. Iron forms an important constituent of the red blood corpuscles, and in all cases of anæmia iron is employed. It is sure to be tried, whether it does good or not. Now the consequences of anæmia are so numerous that you can readily understand that iron will be used for symptoms of all sorts, because in anæmic conditions you not only get the blood diminished in its nutritive power, but the organs which are supplied by the blood all suffer more or less in consequence; so that you have failure of the nervous system, of the digestive system, of the muscular system, and of the vascular system. You find as a common consequence of anæmia shortness of breath, general weakness, and tendency to flushing, very frequently headache, chiefly affecting the vertex, and you also find a great deal of dyspepsia. Now many of those symptoms disappear very readily on the administration of a simple solution of iron. Perhaps the most generally useful solution of iron is the perchloride, and this is given in this Hospital along with quassia.*

* Haustus Ferri cum Quassia :—
Liquoris ferri perchloridi, ♏xv.
Infusi quassiæ, ad ℥i.

There are two infusions which are generally employed with solution of iron, viz., quassia and calumba, the reason being that they give no inky colour. There are several other preparations of iron which are very useful, however, and one is the pilula ferri, in which we have the sulphate of iron with carbonate of potash. Then we have several scale preparations in which iron is combined with quinine, with ammonia, or with potash, and these are less astringent, have less local action upon the stomach and intestine than the perchloride of iron, and so they are frequently employed where there is any tendency to irritability of the stomach or intestine. The acetate of iron is a favourite preparation in cases of kidney disease, where the patient is losing a good deal of albumin, and it may not unfrequently be given with advantage along with acetate of ammonia; 10 to 20 minims of the tincture of the acetate of iron with half an ounce of the liquor ammoniæ acetatis form an exceedingly useful preparation in cases of chronic albuminuria.

Manganese has been employed, as I have said before, as a substitute for iron in cases of anæmia.

ALCOHOL GROUP.—We pass now to a very important class of drugs, but one that I have already discussed so fully when speaking of the nervous system that it is not necessary to say more than a few words regarding it. It is the alcohol group: alcohol, ether, chloroform. These, as you know, in small doses are stimulants; in large doses they tend to act as narcotics.

BENZENE COMPOUNDS.—We will therefore pass on to the aromatic group. The first of the aromatic group is phenol, usually known as carbolic acid. When applied locally phenol has the power of combining with albumin, and when applied to the skin, either pure or in strong solution, it forms a hard scab; it renders the spot white and hard; it causes at the same time some local anæsthesia. It has sometimes been employed externally for the purpose of acting as a local anæsthetic. It causes little or no pain at the time, and so by painting phenol over the surface of a small boil an incision may be made into it without the patient feeling almost any pain. It is one of the best disinfectants that we have, and it is used very largely as such. As a disinfectant it may be employed in strengths of from 1 in 1,000 to 1 in 40 or even 1 in 20. When applied locally to a tooth, it tends to destroy the nerve and to act as a very powerful local anæsthetic, and thus to relieve toothache. One of the best applications that I know in the case of decayed teeth is to put a very small quantity of carbolic acid upon a little bit of cotton wool and stuff it into the tooth. But you must be careful to cover this up with a piece of fresh cotton wool, because if the tongue touches it the caustic action of the carbolic acid will render the mucous membrane of the tongue white by the coagulation of its albuminous constituents, and afterwards it may become painful. As an antiseptic it is used largely for gargles, and a very good gargle in sore throat is half a drachm of the liquefied carbolic acid in 6 ounces of rose-water, but its disadvantage is that the patient must not swallow it. There are some patients who cannot gargle without swallowing, and if they do swallow it they may be poisoned. You must, therefore, be careful when prescribing it to avoid any such risk. When it is swallowed, its effects depend, of course, considerably upon the strength of the preparation.

Carbolic Acid Poisoning.—Pure carbolic acid when swallowed tends to act like every strong acid and to produce all the local effects due to coagulation of albuminous tissues in the œsophagus and in the stomach. Thus you get violent pain all down the œsophagus, pain in the stomach, and vomiting, the same symptoms of gastro-intestinal irritation, in fact, that I have already described when speaking of irritant poisoning. Carbolic acid has an action of its own upon the nervous system. In small doses it tends to act first as a stimulant, and then as an anæsthetic and paralysant; so that it may first of all cause twitchings in the muscles, but these will probably be succeeded before very long by symptoms of paralysis. The patient becomes feeble and collapsed, the respiration and circulation ceasing almost at the same time. It is possible that you may have occasion to meet with cases of carbolic acid poisoning, and it is well to remember that you must try, first of all, to get rid of any carbolic acid that may be present in the stomach, and you endeavour next to neutralise any carbolic acid that may be present in the blood, and this is done by getting into the blood as quickly as ever you can some soluble sulphate, such as sulphate of soda or sulphate of magnesia. But you must also remember that, although sulphate of magnesia is quite harmless when introduced into the intestine, it is a poison when introduced directly into the blood, whereas sulphate of soda is not. Magnesia is a directly poisonous body; sodium is not; so that sulphate of soda introduced by injection under the skin is probably the best remedy that you can use in cases of carbolic acid poisoning. If time will allow, you may give sulphate of soda by the mouth or in the form of an enema, but if there is no time to be lost you had better inject directly under the skin or even into the peritoneal cavity. The reason of this is that phenol is a very poisonous substance, but it unites with sulphates in the body, forming ethereal phenyl sulphates, and in this form it is excreted in the urine.* These phenyl sulphates are not poisonous. In the body it enters into combination with sulphuric and glycuronic acid ($CHO—[CH(OH)]_4—COOH$). Subsequently it becomes changed into the dioxybenzols ($C_6H_4(OH)_2$) pyrocatechin and hydroquinone, and these appear in combination in the urine. Immediately the urine is excreted these substances are set free probably by a fermentative process, and undergo oxidation, giving rise to the brownish green colour which is so prominent a feature of the urine in cases of carbolic acid poisoning.

In cases where carbolic acid has been applied for a length of time externally, especially over a large surface, it may be absorbed, and is passed out in the urine, giving rise to a curious coloration. The urine becomes of a dark green, or brown colour, and this is due to various products of the oxidation of the carbolic acid. This coloration does not usually show danger. It may occur without there being any danger to the patient, but it is always a sign that you require to be cautious

* CH_5,OH,	Phenol.
$HO·SO_2OH$,	Sulphuric acid.
$KO·SO_2OH$,	Acid potassium sulphate.
$CH_5O·SO_2OH$,	Phenyl sulphuric acid.
$CH_5O·SO_2OK$,	Phenyl potassium sulphate.

in administering more carbolic acid. In such a case test the urine for sulphates by adding a solution of barium chloride, which gives a precipitate insoluble in nitric acid with ordinary sulphates, but does not do so with ethereal sulphates. If ordinary sulphates are present in abundance, as evidenced by a copious precipitate of the kind I have described with chloride of barium, you need have no anxiety, but if you do not find many sulphates present in the urine the first thing to do is to put the patient at once upon sulphate of magnesia or soda.

Phenol is a very interesting substance, because it has many characteristics which are developed to a greater extent in one direction or another in other substances belonging to the aromatic series. Phenol has a sweet taste. If you put a little dilute carbolic acid on your tongue you find it is distinctly sweet. You find the same sweet taste occurring in salicylic acid and salicylate of soda, but it is much more developed in another body of this series, viz., saccharine, in which the sweetness becomes intense. Then you find that carbolic acid is a local anæsthetic, and also that when taken internally it seems to have a certain power of acting on the nervous system in such a way as to alleviate pain. In some of the other bodies, such as phenacetin, you find the same tendency to lessen pain still more marked than in carbolic acid. Nearly all of these aromatic bodies act also as antiseptics. The chief use of phenol is as an antiseptic in surgical practice, and it is also used internally largely in order to stop fermentation in the stomach or intestines. Half a grain or a grain of phenol in the form of a pill is one of the most useful intestinal antiseptics that we have. Phenol also tends to reduce temperature, but its poisonous action is so great that it is rarely employed for this purpose.

Salicylic Acid.—This power of reducing temperature is much more marked in the case of salicylic acid, and as this is sparingly soluble, it is generally given internally in the form of salicylate of soda. This substance is used now very largely as an antipyretic, more especially in cases of acute rheumatism. In this disease we find not only that the temperature comes down almost at once after the administration of salicylate of soda, but the severe pains in the joints which previously troubled the patient very quickly subside. It is said that salicylate of soda does not tend to prevent the inflammation of the heart and vessels which so frequently accompanies rheumatic fever, and which gives rise afterwards to disease of the heart, but at the same time it is so useful in lessening the temperature and relieving the pain that it is the drug which is chiefly employed now for the treatment of rheumatic fever. You generally give about 20 grains of the salicylate of soda, every two hours at first until the temperature begins to come down, and the pains are relieved, after which you may increase the intervals between the doses to three, four, or six hours. It is generally advantageous to continue the administration of salicylate for some little time after the temperature has been reduced, because, unless you do so, the temperature tends to rise again.

There are certain uncomfortable symptoms that are produced by salicylate, and which you require to be acquainted with. The first symptom of its disagreeable action may be a tendency to vomit. This is often due simply to the curious mawkish, sweetish taste that the drug has, and it may be overcome by combining it with something that is agreeable to the patient. Commonly one gives some compound tincture of cardamoms and some spirit of chloroform, but I think the taste is almost better covered by the addition of a few grains of bromide of potassium. It is sometimes given along with liquorice, and many patients do not seem to object to this mixture at all. The more important symptoms, however, are those affecting the nervous system, and the first thing the patient tells you is that he has singing in his ears and he is perhaps rather deaf. That is the first indication of an affection of the nervous system, but the cause of this may not be in the ears, and I am inclined to think that it is more probably due to irritation in the nerve centres, because now and again you find that the optic nerve appears to be irritated in the same way as the auditory. There are lots of people who, when they take salicylate of soda and shut their eyes, see disagreeable visions, which would not appear unless they were taking the drug. Now and again these visions become visible even when the eyes are open, and the first time you see a case of this sort you may be a good deal puzzled. I remember the first time I saw a case I could not make out what was the matter. The patient was an elderly gentleman, and one day he complained that he was seeing troops of people going round his bed. I thought at first he was delirious, his temperature was not febrile, and then it occurred to me that his visions were due to irritation either of the optic nerves or of the visual centres in the brain by the salicylate of soda, and this turned out to be correct. I have seen one or two cases of the sort since. In the form of less soluble salts, such as salicylate of bismuth, salicylic acid is exceedingly useful as an intestinal disinfectant, and tends to lessen both irritation and decomposition in the intestines. It is an excellent remedy in chronic intestinal pain of rheumatic or gouty origin. Salicylate of phenol, or salol, is very frequently used as an intestinal disinfectant, the common dose being 10 grains given in a cachet.

Benzoic acid is also an intestinal disinfectant, but it is not very often employed except in the form of benzoate of soda, or rather benzoate of ammonia, which is a very common remedy indeed in cases where patients suffer from decomposition of urine in the bladder, so that it becomes ammoniacal and irritant. The benzoate passing out as hippuric acid tends to act as a vesical antiseptic, and thus renders the urine more nearly normal.

Phenacetin, as I have said, is a drug that is used a good deal to reduce temperature and also to lessen pain. It lessens the pains of headache and of neuralgia. Five-grain doses of this drug are frequently sufficient to relieve the pain of headache or neuralgia, but if this be not sufficient you can run up to 10 or sometimes up to 20 grains. Antipyrin has much the same effect as phenacetin, and antipyrin is perhaps even better than phenacetin in some cases, although, I think, as a whole, phenacetin is to be preferred. In cases where the pains depend upon changes in the spinal cord, as, for example, in locomotor ataxy, both antipyrin and phenacetin remove them.

Now phenol, salicylic acid, salicylates, phenacetin, and antipyrin have all another characteristic in common: they all tend more or less to depress the action of the heart, and, therefore you are always careful about the administration of these drugs where the action of the heart is weak, and if you have occasion to employ them for any length of time together, you are accustomed to give along with them some cardiac stimulant, as, for example, spiritus ammoniæ aromaticus. It is best to mix this with the other drugs at the time when they are taken, for otherwise the mixture seems to undergo some sort of decomposition. I do not know the nature of it, but in a day or two the patient brings back the bottle and tells you that the medicine has gone bad. The chemist says it cannot be prevented. It is therefore better to give the patients directions to take the ammonia separately from the antipyrin or phenacetin which you have prescribed, or else just to mix them at the time of taking.

The collapse which occurs in poisoning by phenol may occur also after antipyrin or phenacetin, and this tendency to collapse appears to be associated, in the case of phenacetin and antipyrin, with a certain tendency to decomposition of the blood, so that the patient gets a somewhat livid colour. This condition appears to come on much more readily in women during the menstrual period than it does under ordinary circumstances, so that it is advisable to be careful about the administration of these drugs to women while they are menstruating. Now it is just at this time that you are very likely to give them, because it is just at the menstrual period that women suffer more from headache than in the intervals, so that one cannot say, Do not give them to your female patients at this time, but in such be careful, and feel your way with each individual patient, because this appears to be to a great extent an idiosyncrasy of the patients who suffer in this manner. It is a good plan to begin with small doses and increase them gradually so that you may be quite certain that you are not doing the patient any harm. There is another drug which belongs to the same series, but which is a much older one than these, and that is quinine. Quinine has the effect of acting as an antiperiodic and it is the most powerful one that we know. It is an antiseptic, as well as an antiperiodic. In small doses it acts as a general tonic, increasing the appetite and making the person feel stronger. The first indication of poisoning is the same as that in salicylate of soda, viz., ringing in the ears, very often like the sound of bells, accompanied by a certain amount of deafness. There is also a good deal of heaviness in the head, and many patients object to quinine on account of the headache and heaviness it causes. In some persons quinine and all the others, phenol included, have a tendency to act upon the skin after they have been absorbed. It would seem that in the process of excretion they reach the skin, and there they act as irritants, and sometimes they give rise to a good deal of itching, at other times to well-marked rashes. The rashes vary a good deal in character: sometimes they may simply be little papules, with nothing more ; at other times you get erethematous patches, large red patches, and not unfrequently you may get well-marked urticaria or nettle rash. These rashes may follow the use of almost any one of the members of the aromatic group which I have mentioned. Very large doses of quinine have been known to produce convulsions. They produce them in dogs, but I have only known of one case in which this occurred in man. They have been also said to cause contraction of the uterus and premature expulsion of the fœtus, so that one is careful about giving large doses of quinine to women who are pregnant.

LECTURE 34.

Arsenical poisoning—Quinine, *continued*—Hypnotic action of antipyrin and phenacetin—Opium—Morphine—Codeine—Thebaine—Uses of opium—Opium, alcohol, and apoplexy—Treatment of opium poisoning—Morphine habit—Opium-eating and alcoholism—Cannabis indica—Hyoscyamus—Belladonna and atropine—Cocaine—Antagonistic alkaloids in crude drugs.

GENTLEMEN,

When speaking of arsenic I omitted to describe the symptoms which indicate that the drug is producing its physiological action, and that it is time either to lessen the dose or to stop the administration of the drug altogether. When you are giving arsenic internally, either for its action as a remedy in skin disease or as a nervine tonic in cases of chorea, you carefully watch for certain symptoms. These indicate irritation either (1) in the eyes, or (2) in the stomach. Irritation of the eyes shows itself as itching, discomfort, or desire to rub them, which are apparent to the patient, and a redness of the eyes or eyelids, which is apparent to the medical attendant. There is frequently first of all a greatly increased appetite; but this is either accompanied or quickly succeeded by pains in the stomach and the epigastrium, and whenever either of these symptoms or both of them appear, you lessen the dose of arsenic or stop it altogether.

At the end of last lecture I referred to the action of quinine on the genital organs and to the possibility, when given in large doses to pregnant women, of its bringing on abortion or premature confinement. There is another action of quinine upon which less stress is laid in the ordinary text-books, but which nevertheless exists, and that is an irritant action upon the urinary bladder; so that in persons in whom the bladder is irritable quinine has sometimes to be stopped or not given at all, because it produces in them such desire to micturate that life becomes a burden. This occurs, I think, more especially in old men, in whom irritability of the bladder is more readily seen. Quinine, as I mentioned, also produces a tendency to various rashes, so that when giving quinine you must look out for the appearance of these rashes, which sometimes cause a good deal of discomfort. You will remember that I told you it is of very little use to give quinine when the liver is congested; that in cases of ague or malarial fever, when you are giving quinine, you should administer first of all a mercurial purgative, say a blue pill or 5 grains of calomel, and after that a black draught, so as to clear the liver thoroughly out. In India a great deal of quinine is wasted, because very often people simply have a big jar of quinine upon the sideboard, and everybody goes with a teaspoon and helps himself; but when taken in this way the quinine is floated either upon water or upon milk. Quinine cannot be absorbed any more than other substances unless it is in solution, and when a teaspoonful of quinine is put into the stomach there is rarely sufficient acid present in the gastric juice to dissolve it. A great portion of it, therefore, passes through the stomach, and once it gets into the intestine, it meets with no acid, but only with alkaline juice, which cannot dissolve it, and so a great deal of quinine simply passes through the intestinal canal without being absorbed. Very often you will find that 10 grains of quinine given with plenty of acid to dissolve it will have more effect upon the system than 30 grains without the acid. One advantage, however, of floating the quinine upon water or upon milk is that it has very little taste, and people take it without any dislike; whereas if you use a very strong solution it has a very bitter taste. This bitter taste is very persistent if you give quinine with only enough acid to dissolve it; but if you give an excess of acid and tell the patient to take some water afterwards, the bitter taste passes off, and leaves a sweet after-taste which is rather pleasant.

It is very curious when considering groups of medicines to notice how the same thread runs, as it were, through them. Quinine has not any markedly hypnotic action ; it does not, as a rule, tend to put people to sleep. But some of its allies, antipyrin and phenacetin, sometimes do act as hypnotics, and you can readily understand why they do so. I said when speaking of sleeplessness that sleep depends upon quietude of the brain, resulting partly from the condition of the brain-cells and partly from a diminished supply of oxygenated blood to them. An active condition of the heart and a rapidity of the circulation tend to keep up oxygenation of the brain-cells and a continuance of their functional activity. If you can quiet the heart and lessen the circulation, you tend to quiet down the brain as well as the other organs of the body. I showed you that heat is a most potent stimulant to the heart, and so when the temperature of the body is high the heart beats powerfully and quickly, the circulation through the brain, like the circulation through other organs, becomes very rapid, and so the patient does not get to sleep, and we get the wakefulness of fever. If you give antipyrin or phenacetin and lower the temperature of the body, you not only remove the stimulus of heat from the heart, thus quieting its action and lessening the circulation through the brain, but you remove the powerful stimulus which heat affords to the brain itself, and thus you allow the patient to get to sleep. Phenacetin and antipyrin, then, when given at night to a feverish patient, will sometimes act as powerful hypnotics.

Opium.—We now come to another drug which is one of the most important in the whole of medicine—viz., opium, with its alkaloid morphine. Now morphine, which is the most important of the alkaloids in opium, has little or no hypnotic action upon birds in whom the temperature is much higher than in mammals, but it has upon them a very powerful antipyretic action. It will sometimes lower the temperature of a pigeon as much as 7°, although it does not appear to act upon it as a hypnotic. In mammals you do not notice this antipyretic action nearly so much, if at all, but the hypnotic action is very marked. There are several alkaloids in opium; morphine, codeine, and thebaine are the three most important, and the interesting point about them is that each has an entirely different action. They form a regular series, in which you have at one end an almost pure hypnotic and at the other end a pure convulsant. Morphine is an almost pure hypnotic, although in frogs it has a convulsant action. Thebaine has no hypnotic action; it is a pure convulsant, almost like strychnine. Midway between those two we have codeine, which has very little hypnotic action and very little convulsant, but has a somewhat analgesic action, tends to lessen pain, and it has a considerable influence in modifying tissue change, so that we get in the alkaloids of morphine a curious series.

Uses of Opium.—Opium and its alkaloids are used for three purposes. The most important is that they relieve pain and spasm; the second is that they produce sleep; and the third is that they alter tissue change. We use opium and morphine to alter tissue change in diabetes, and in this disease we find that codeine, which has little hypnotic and little stimulant action, is nearly, though perhaps not quite, so powerful as morphine itself. Opium is used externally to lessen pain, although it is hardly absorbed, if at all, from the skin. Nevertheless the decoction of poppy-heads is frequently employed in order to lessen pain, whether this be in a joint, in a limb, or in a serous cavity such as the thorax or abdomen. Probably a great deal of the good effect which undoubtedly results from fomentations with poppy-heads is due simply to the hot water. At the same time we find that opium is frequently used in the form of tincture spread upon fomentations, and sometimes we find that solution of opium mixed with solution of belladonna and smeared upon a piece of lint is applied over the surface of the abdomen in order to lessen abdominal pain, but absorption takes place very slowly, if at all, through the epidermis. If the epidermis be removed, the morphine is very much more quickly absorbed, and then it may be employed by the endermic method to relieve neuralgia. Some neuralgias are so obstinate that you want to try all sorts of remedies for them, and this is one that sometimes answers. You put a little blister on about the size of a thimble, and when it has risen you snip the epidermis off and dust the morphine over the spot. More generally, however, for the relief of pain, we use morphine by subcutaneous injection, and it tends to cause quiet in a very short time, although the relief may pass away as the morphine is excreted.

In the mouth we use morphine in order to lessen pain. A little tincture of opium or liquor morphinæ mixed with bicarbonate of soda and rubbed over the gums frequently relieves the pain, which is due to soreness and tenderness of the gums, and when introduced by a small pledget of cotton-wool into the cavity of a carious tooth, not only does it relieve the local pain, but that radiating pain which goes all over the head and accompanies the local pain. Sometimes you may relieve severe headaches by stopping a hollow tooth with bicarbonate of soda and opium.

In the stomach small doses of opium are used to relieve pain and sickness ; large ones tend to cause stoppage of secretion in the stomach and interfere with its movements, so that digestion is impaired. Opium is used for the purpose of lessening irritability of the stomach, and so relieving pain in the stomach or arresting vomiting. In cases of obstinate vomiting, morphine is very frequently employed in doses say of 10 minims of the liquor, and occasionally you may get benefit by combining this with hydrocyanic acid and cocaine or belladonna. Morphine not only relieves pain in the stomach, but does so in the intestine also, and lessens their irritability, so that this drug or opium is very much used in the treatment of diarrhœa. We have in the Pharmacopœia various compounds of opium which are intended specially for this purpose, and which I have already discussed.

There are two ducts in the abdomen which, when distended by calculi, give rise to most excruciating pain : the gall-duct and the ureter. The excessively severe pain which occurs during the passage of a gallstone or a renal calculus is usually most readily relieved by the subcutaneous injection of morphine. Sometimes you may afford relief in cases where you are not likely to be at hand to administer a hypodermic injection by giving the patient a mixture of morphine, ether, and chloroform. We have in the Pharmacopœia tinctura chloroformi et morphinæ (B. P.), which is intended for cases such as this. It is an imitation of the patent medicine chlorodyne, but I have found that the admixture of the compound spirits of ether, known as Hofmann's anodyne, with opium or with chlorodyne seems to quicken the relief to the pain of gallstone which they give. In many cases one has to be very chary of giving injections to patients, lest they get into the habit of taking them, and it is always a good rule not to entrust the subcutaneous syringe to them, because there is then great risk of their getting into the opium habit.

Small doses of opium stimulate the brain, and the stimulation may take various forms according to the wish of the person who is taking the opium. Sir Robert Christison used to say that if a small dose be taken, and the man puts himself to sleep, he goes to sleep beautifully, but if, instead of yielding to the desire to sleep, he wishes to go into society, he then becomes bright and talks with greater freedom, with greater ease, and with greater brilliancy. If, on the other hand, he wishes to study, his brain becomes more clear, and he can solve problems which he could not do in his ordinary condition. You see, therefore, that the action of opium is very much the same as that of alcohol, and how far the apparent increased power is due to the feelings of the patient being dulled or not it is hard to say, because the subject really appears to want to be gone over again by experimentation in a more careful way. After the first stimulant effect has passed off, it is usually succeeded by the soporific action of opium, so that the patient becomes very drowsy and can hardly resist the tendency to sleep. If the dose be much larger, the first stage of stimulation is much shortened, the sleep comes on more quickly, becomes more and more profound, and the patient falls into a state not of ordinary sleep, but of coma, from which he can hardly be awakened. A great deal of discussion has taken place about the condition of the brain in the comatose state and in the sleep produced by opium. It has been found that in the stage of sleep the brain is anæmic, but that during the stage of coma the brain is hyperæmic. This hyperæmia, however, is not arterial; it is venous hyperæmia. The difference between the brain in the stage of sleep and the stage of coma produced by opium is the same difference that is seen in the hands of a boy after he has been snowballing or exposed to cold. You first get the stage of white hands from arterial anæmia, and then that of blue hands from venous hyperæmia. Now the amount of opium necessary to produce this comatose condition varies very much according to the individual, and especially according to the age of the individual, so that children below five years of age are especially liable to be affected by opium and to die from comparatively small doses. Therefore one rule is that you should not give opium to children under five without the very greatest possible care, so that they should be carefully watched and subjected to stimulant treatment if the sleep seems to tend to pass into coma.

There is another curious condition which affects this sleep, and that is that the drug may lie a long time in the stomach without being absorbed. I was once called in to see a case of opium poisoning in the wife of a medical man who happened to live next door to me some years ago. The doctor told me that his wife had been suffering from neuralgia, and the night before she had taken a dose of opium which had no effect whatever; it did not cause sleep, and it did not lessen the neuralgia. She took another dose in the middle of the night, and still without effect; she had another dose towards daybreak, fell asleep about eight o'clock in the morning, and remained asleep all day. When I was asked to see her at eight o'clock the second night she was in a state of coma, and we could not arouse her. The three doses, each of which alone was not sufficient to produce any comatose condition, had apparently lain unabsorbed in the stomach for a length of time; and then the whole had been absorbed at once and had produced coma. We proceeded to try and wake her by the means which one usually employs under such circumstances; that is to say, we dragged her out of bed and walked her up and down the room, her husband holding one arm and I the other. There is a plan sometimes employed of flicking with a towel just to give a smart sensory stimulus, and thus to awake the patient if possible; but an easier way is simply just to tap upon the forehead with the finger-nails. This gives a short, sharp stimulus which tends to wake the patient without leaving any mark. If you happen to have a battery at hand, it is still better, because the application of a faradic current is the easiest way of bringing patients round from the effects of opium. Another plan is to give alternate hot and cold douches, but you must be careful not to chill your patients down when they are suffering from opium poisoning, because it sometimes happens they recover from the opium sleep and then collapse. You must remember the possibility of this occurring, and not use such measures as are likely to depress the patient's strength too much.

Alcohol; Opium; Apoplexy.—It is sometimes very difficult to know whether a patient is suffering from opium poisoning or not. Many of you will no doubt take positions as house physicians or house surgeons, and you will be called up about two, three, or four o'clock in the morning by the police who have brought in a patient who has been found unconscious, and you will have to decide whether the patient is suffering from alcoholic poisoning, or opium poisoning, or paralysis. In such cases one of the first things one does is to smell the breath in order to detect whisky, brandy, or gin; but this to a certain extent is misleading, because it often happens that when a man is found lying senseless in the street some bystander tries to pour some whisky or brandy down his throat, and so you get the smell of alcohol, although the man may have taken none. In cases of alcoholic poisoning you are likely to find the pupils somewhat dilated, the pulse is full and soft, and the surface tends also to be rather warm; in cases of opium poisoning you may sometimes notice a smell of opium, but it may easily be disguised by the smell of alcohol with which it may be combined. You look at the pupils, and you notice whether they are much contracted. In opium poisoning they are very likely to be contracted to a pin-point. The next thing you notice is, Are they equal? because this pin-point condition of the pupils occurs not only in opium poisoning, but in a form of paralysis which is likely to run a rapid and fatal course: in hæmorrhage into the pons varolii. If you find they are unequal the chances are that it is hæmorrhage, and not opium. You lift up the hands and see whether they fall equally or whether there is any rigidity on the one side or the other. If the two hands are unequal you know that in all probability you have to do with hæmorrhage into the brain upon one side, and not with a drug which will act upon both sides of the brain equally like opium. Still in all the cases you get it is better to err on the safe side and to keep your patient under careful observation rather than to say at once to the police, "This man is drunk, or he has been taking some drug; take him away to the cells."

It is sometimes exceedingly difficult, and indeed I believe almost impossible, to tell whether the man has hæmorrhage into the brain or whether his symptoms are due to some drug. If you get the history of the patient having taken opium, the first thing to do is to wash the stomach thoroughly out by means of the stomach tube. The best thing to employ is the soft rubber tube and funnel which I showed you on a previous occasion. After this pour into the stomach a lot of hot coffee, and then if the patient is not coming round you can inject some atropine, say 2 minims of the liquor atropinæ sulphatis every ten minutes, under the skin until you see that the patient's pupils are beginning to dilate, or the pulse commences to get excessively rapid. In either case you know that you have now got the full physiological action of the atropine and need not push it any further, as it would be injurious rather than beneficial. Artificial respiration might be useful if you could keep it up long enough, because death in opium poisoning takes place from paralysis of the respiration, and the heart goes on beating a long time after the respiration ceases. The difficulty is to keep it up for a sufficient length of time; but supposing you are called in to some wealthy person who has been poisoned by opium, and you can get relays of people to keep up artificial respiration, it is worth while to do so, and it is just possible that you might get him round even after twenty-four or forty-eight hours of artificial respiration. I do not see why a person should die of opium poisoning if one could manage to maintain artificial respiration for a sufficient length of time and at the same time keep the body warm, so as to maintain the circulation.

Even after a moderate dose of opium there is apt to be discomfort next morning. There is headache and a little tendency to feel sick. The very drug which is used so much to lessen sickness and vomiting tends of itself to make the patient sick next morning. Now in all probability this is due to the excretion not of morphine, but of some product of the decomposition of morphine, from the blood into the stomach itself. The mucous membrane of the stomach does not excrete into its cavity simply gastric juice; it excretes other things which are present in the blood, and amongst other things, as I mentioned before, it will excrete tartar emetic if present in the blood. It will also excrete some of the products of the decomposition of morphine, and some of these products have a most powerful action. The most important of these is apomorphine, which is not contained in opium itself, but is made by heating morphine in a sealed tube with hydrochloric acid. Apomorphine has a most powerful emetic action, and probably oxydimorphine and other substances produced from morphia have a similar action. If you give to a patient suffering in this way another dose of morphia the effect of the products of decomposition is at once removed, the nausea ceases, and the patient feels all right again.

Morphine Habit.—It would appear as if the more morphine you give the more you require to give, because in a person who is taking large quantities of morphine so much of the products of its decomposition has to be antagonised before any result ensues from the morphine itself. Sometimes the quantity taken is enormous. The largest quantity that I have ever met with was in the case of a member of Parliament, who took 24 to 32 grains of morphine subcutaneously every day; 24 grains was the minimum, 32 grains the maximum. He used to take the syringe with him to the House of Commons, and while sitting with his arms quietly crossed he stuck the needle into his biceps and injected morphine, or he had his hand lying apparently quiet on his thigh and made the injection. He used to carry a syringe ready charged in his waistcoat pocket. This man was not to blame at all for acquiring the habit, because it was the very fineness of his character which led to his acquiring the habit. His daughter had been very ill, he was watching during a great part of the night, and even when he was not by her bedside he could not sleep. He was also in very large practice as a lawyer, and it was most important that the clients who had engaged his services should have the best he could give them. He saw that if he remained awake all night he could not argue his cases as he ought to during the day, and so he found it necessary to use something to make him sleep, and he took morphine as a matter of duty. But after he had begun to take it he could not get on without it, and so the practice grew and grew. He made a very brave attempt to give it up, and the suffering he went through was simply awful. He was told that he would have to go through hell before he rid himself of the habit, and the poor man said one day, "Yes, doctor, but there are grades in hell, and I have got down to a very low one." Sometimes the condition of the patients becomes so frightful that you have to give them a little morphine just to tide them over and prevent them dying in the attempt. The condition they get into is one of the most indescribable misery. What the exact nature of the misery is one cannot tell unless he has been through it. In addition, you get physical depression; the pulse becomes so small and feeble that you can hardly feel it; the face gets pale and slightly bluish; and there may be a considerable amount of diarrhœa. In fact, one of the patients I have seen, who was trying to get rid of the morphine habit, simply presented the appearance of a person suffering from Asiatic cholera, though I suppose the symptoms were due only to the action of the products of the decomposition of the morphine he had previously taken. In the end we were simply obliged to give him a little morphine, but usually one tries to avoid this if possible and use other stimulants instead. One occasionally uses alcohol, and cocaine has been used especially with great effect, but there is a great disadvantage in employing it, because you may pass from the morphine habit into the cocaine habit, which seems even worse than the morphine.

Opium-eating and Alcoholism.—Now we find in different countries that diseases which are new are much more dangerous. I daresay most of you remember when measles was introduced into the Fiji Islands what a sweep it made there, and how it cleared out a great portion of the population, although measles here is not by any means such a dangerous disease. If you plant a disease amongst a population who are unaccustomed to it, it makes great ravages, but in the next generation all those who are most liable to the disease have been carried out, and so you do not get such a large proportion of the population suffering from the disease. You have such a selection that the population then alive are more or less resistent to the disease. It appears there is something of the same sort in the case of habits. If you plant a habit of alcohol-drinking in a new population, as, for example, amongst the Red Indians, it is most fatal, for it carries them off in hundreds. It is bad enough in this country, but it is nothing like to what it is in a new country or a new population like the Red Indians. Now, if we were to plant alcohol in India, the probability is that it would prove a much greater curse than it does to us. When people in this country acquire the opium habit, it is most pernicious. The habit of opium-eating amongst the Westerns seems to be worse than amongst the Easterns, because in India and in China people appear to have been accustomed to take opium for centuries, and there are a great number of people in these countries who take opium precisely as men take alcohol here. In this country you will find thousands of men, or tens of thousands, who take their glass of beer or wine twice or thrice a day, and never exceed, and never wish to exceed, it; they feel all the better for it, and probably are really the better for it. In China and India you find men who take their opium in precisely the same way: they take a small quantity twice or thrice a day, they feel the better for it, and they never want to exceed it. We hear very little or nothing about these people, because there is nothing prominent, nothing to attract attention, about these perfectly sober men, but we hear a great deal about the opium dens and about the mischief that is done by opium in foreign countries. It is just the same in India and China with opium as it is here with alcohol. There are a number of people in this country who are destroyed by alcohol, and there are a great number, though I should think a smaller proportion, destroyed by opium in India and China, but the two drugs are used in the East and West for precisely the same purpose and in almost exactly the same ways. By the same ways, I mean that they are used by many regularly and temperately, and by a few to excess. But if we were to transfer the habit of one set of people to another we should probably do much injury, and if we were to get opium-eating transplanted over here much damage would be done, and the same would be the case if we were to get alcohol-drinking taking the place of opium-eating in India.

Cannabis Indica.—There are several other things that are used in place of opium in order to produce sleep. I mentioned to you that salicylate of soda has a tendency to produce visions. Another drug which is used frequently as a hypnotic has a tendency to produce visions as well, and that is cannabis indica. This produces a sort of waking delirium, and in large doses it tends to make the patient perfectly mad. It is a useful sedative in moderate doses, and may be given up to 20 minims of the tincture three times a day. Beyond this I have not found it do any good; in fact, it then seems to be a poison, so that on one occasion a patient of mine took more than 20 minims and got a waking delirium that alarmed his friends very much.

Hyoscyamus.—Hyoscyamus, or henbane, is a drug which, in the form of the tincture, is not unfrequently employed as a sedative in order to produce sleep; it is also used as a sedative to the bladder. There is another drug, hyoscine, which is a still more powerful hypnotic, and a dose of $\frac{1}{200}$th of a grain of it sometimes is quite enough to cause deep sleep. Hyoscine is a tremendously powerful drug, and must be used in very small quantity. It is probably the best drug we have for quieting the tremors of paralysis agitans. In a small dose, $\frac{1}{500}$th of a grain, injected subcutaneously, it quiets the tremors for a considerable length of time.

Belladonna and Atropine.—Closely associated with these is atropine, the active principle of the atropa belladonna. Belladonna has the power, as well as its alkaloid atropine, of stimulating nerve centres and paralysing peripheral nerves. On account of this, when belladonna berries are eaten by children or when a dose of belladonna is given too frequently to a patient or is too large, a kind of delirium may set in, which is characterised by being very active and busy; the patient always wants to be doing something, and this is due to the stimulation of the nerve centres. At the same time this very business is accompanied by a great deal of languor and disinclination to move, because the peripheral ends of the nerves are weakened, and so there is a difficulty in the way of the excited centres causing any movements in the muscles. It is only in very large doses, however, that atropine will paralyse the motor nerves completely, or at least the motor nerves going to voluntary muscles. In smaller doses it will paralyse the efferent nerves which end either in involuntary muscular fibres, in glands, or in ganglia. In comparatively small doses then it will paralyse the efferent nerves which end in the ganglia of the heart and are connected with the vagus. It paralyses the vagus ends; it paralyses also the secretory nerves of almost all glandular organs: of the salivary glands, lachrymal glands, sweat glands, milk glands, and pancreas. It does not seem to have any great influence upon the glands of the intestine. On account of this power, it is used in salivation, in excessive sweating, or in order to stop the secretion of milk, and may be applied for this purpose either locally or generally. To lessen sweat, it is sometimes used locally as a wash, but is more generally given internally. To lessen the secretion of milk, it is generally employed either in the form of an ointment smeared upon lint or of a plaster applied to the breast. On account of its having a certain local action in paralysing the ends of sensory nerves as well, it is to a certain extent a local anæsthetic; at any rate, it lessens pain; and so the ointment of belladonna is frequently employed in order to lessen the pain in fissure of the anus. In cases of irritable bladder or irritable rectum belladonna ointment may be applied in the form of a suppository. In cases of very irritable bladder associated with pain due to prostatic inflammation, or in cases of cancer either about the bladder or about the rectum, one sometimes gets very good results from a suppository containing a little belladonna, a little morphine, and a little cocaine made up with cacao butter.

One of the best remedies that we have in cases of palpitation is a belladonna plaster. No doubt a good deal of the action of this is simply mechanical, but part of it may be due to the local effect of the belladonna upon the terminal branches of sensory nerves in the skin. In putting on such a plaster you must be careful that it is cut so that it can fit close to the heart. It is generally used in cases of women, and if put on without a cut or two in it, it will not fasten firmly over the breast, but by making a cut or two in it with a pair of scissors, thus—

you can manage to make it fit quite comfortably over the breast. In cases of lumbago a belladonna plaster is of very great use, but you must use a very big one, as a little one is of very little use. The plaster should be about 18 inches long by about 8 inches broad, and in applying it there is a tendency for the patient to stoop down and put it on while he is in that position, but whenever he does this the belladonna plaster becomes loose and wrinkled the moment he stands up. What he ought to do is to bend as far backwards as he can, put the plaster on, and then when he stands straight it gives him support and rucks up very little. I mentioned that belladonna was used in the form of atropine to lessen night sweats, and that $\frac{1}{200}$th or $\frac{1}{100}$th of a grain given at night will frequently either lessen greatly or completely arrest the night sweats in phthisis. Atropine is also much used in order to lessen irritability of the bladder in cases of incontinence of urine, and in such cases you must push the belladonna until the physiological action has been obtained, and the same must be done sometimes in cases of irritability of the heart. Now the physiological action of atropine is shown by the occurrence of dryness of the mouth or dilatation of the pupil, and sometimes by very great rapidity of the heart's action. The three most characteristic symptoms of poisoning by atropine are (1) paralysis of the salivary nerves, leading to dryness of the mouth; (2) paralysis of the 3rd nerve, causing dilatation of the pupils, with imperfection of vision; and (3) paralysis of the inhibitory fibres of the vagus in the heart, causing very rapid action of the heart. Therefore, when any of these three occur, you know that the belladonna is producing its physiological action, but, as a rule, you get dryness of the mouth before either of the other two, and when this comes on it is a sign that the dose should be lessened or stopped altogether.

Cocaine.—Cocaine is another drug which has a more powerful local action upon the ends of sensory nerves than atropine has. Both cocaine and atropine tend to lessen the irritability of sensory nerves, but cocaine does so to a greater extent, so that when applied locally it will produce complete local anæsthesia. It is used for this purpose in cases where you wish to perform operations on the eye or upon any mucous membrane without giving a general anæsthetic; it is applied to the throat to facilitate the use of the laryngoscope whenever the throat is irritable. You paint a 5 or 10 per cent. solution of cocaine on the pharynx, leave it for a few minutes, and then the irritability will have disappeared, and you will be able to get a good view of the vocal cords in cases where you could not otherwise see them. Very often a 5 per cent. solution is quite sufficient for this purpose, and the weaker the solution the better for the patient, because when you use a strong one it leaves a curious feeling in the throat, which the patients sometimes say feels as if a bit had been cut out of it. If you have time, you may apply the 5 per cent. solution; when you are in a hurry, you may use 10 or even 20 per cent., but it is always better to use the weaker solution. It is applied locally for many other purposes, as you can readily understand, when a local anæsthetic is required to lessen pain, as in toothache or itching in pruritus or eczema. One disadvantage about it is that it tends to cause sleeplessness. Even when applied to the skin in the form of an ointment, so much of it may be absorbed that the patient does not sleep. There does not seem to be much discomfort attending the insomnia, but it is just the same sort of sleeplessness that occurs after drinking green tea or after taking too strong coffee. The patients tell you they cannot sleep at all, and unless you knew the effect of cocaine upon the brain you might wonder what the cause of this sleeplessness was. In cases where the application of cocaine is producing this effect, you must leave it off, or else combine with it a larger dose of morphine, as in such cases as I have already mentioned, where you are using it for cancer.

Antagonistic Alkaloids in Crude Drugs.—Now in opium we have three alkaloids forming a series, and you can see that two of them are to a certain extent antagonistic. For example, morphine tends to lessen the excitability of all the nervous centres; it lessens the excitability of the respiratory centre, so that the patient or animal who has taken too large a dose dies of respiratory paralysis. Thebaine, on the other hand, has the effect of stimulating the respiratory centre just like strychnine, and so is to a great extent antagonistic to morphine. Therefore in giving crude opium you are giving several drugs, two of which have an antagonistic action. This is not an isolated instance, because in jaborandi we find two alkaloids which have a completely antagonistic action. One of them, jaborine, has an action almost identical with that of atropine: it paralyses all the secreting nerves throughout the body, just as atropine does; the other one, pilocarpine, stimulates those nerves to an extraordinary extent, so that it causes salivation, very profuse sweating, increased secretion from the pancreas, increased secretion from the intestine, as well as increased movement from stimulation of its motor nerves, so as to cause well-marked diarrhœa. Jaborine has exactly the opposite action, and it may possibly occur that you get hold of a specimen of jaborandi which has no apparent action whatever, because the alkaloids in it are so nearly balanced that the one completely antagonises the other. This does not generally occur, because the amount of pilocarpine is usually much greater than that of jaborine, so much greater, indeed, that jaborandi leaves are usually employed in the same way as a solution of pilocarpine. But you must always remember that in the infusion of jaborandi leaves you have the two alkaloids. In the case of calabar bean, we have a similar condition. It also contains two alkaloids: physostigmine and calabarine. The physostigmine tends to contract the pupil by its local action on the terminations of the 3rd nerve, it tends to paralyse the spinal cord, but calabarine has a stimulant action upon the spinal cord much like that of strychnine, so that the two alkaloids have an antagonistic action.

Strychnine.—In the case of nux vomica we have two alkaloids, strychnine and brucine, which, instead of having an antagonistic action, have a similar action, but strychnine is a great deal more powerful than brucine. The action of strychnine is that of a stimulant to the nerve centres, and on this account strychnine and nux vomica are perhaps more used as tonics than any other drugs. Strychnine tends to increase the appetite, circulation, respiration, and digestion. It is one of the most powerful stimulants to the respiration which we possess, and in a case of failing respiration subcutaneous injection of liquor strychninæ is the most powerful remedy at our disposal. You all know that the respiratory centre is situated in the medulla oblongata. If you cut across the spinal cord of an animal just under the medulla, it ceases to breathe. But if you inject some strychnine after it has ceased to breathe, respiratory movement again commences, or if you inject strychnine first and then cut across the cord, respiratory movements do not entirely cease. It thus appears that, although the chief part of the respiratory centre is situated in the medulla oblongata, there is an extension of it, which is less powerful, into the spinal cord. This spinal respiratory centre is not sufficiently powerful under ordinary circumstances to maintain respiration, but if you stimulate it by strychnine, it becomes sufficiently powerful to keep up respiration to a certain extent. Now the same action that it has upon the respiratory centre it has also upon the heart. Most of you know from your physiological studies that if you tie a ligature tightly round a frog's heart the heart stops. Now, if you inject into this heart before you put on the ligature a little solution of strychnine, it does not stop beating, as the normal heart would do, and if you inject solution of strychnine into the ventricle when its beats have stopped after the ligature, they recommence. So this drug is probably the most powerful stimulant to the respiration and to the heart which we possess, and in cases of failing heart, when the patient is apparently dying, you may do him an immense deal of good, and sometimes bring him round, by subcutaneous injections of liquor strychninæ.

LECTURE 35.

Strychnine, *continued*—Treatment of strychnine poisoning—Dangers of digitalis—Volatile oils—Turpentine as a hæmostatic—Camphor—Ergot—Poisoning—Medicinal uses—Cantharides—Colchicum—Aconite – Filix mas—Cod-liver oil.

GENTLEMEN,

In regard to strychnine, the question arises, What limit must you put to the amount of the drug to be injected? Probably one would not like to inject a larger quantity than about 10 minims in two hours, but in cases of great need it may be requisite to push it even further, and, as I think I mentioned to you in a previous lecture, I once succeeded in saving a patient's life by pushing the strychnine until I made his fingers jump. This was the first indication of the so-called physiological action of strychnine—the toxic action. There were no regular convulsions, but there were slight twitchings in the fingers. Strychnine is frequently given as a nervous stimulant in cases of paralysis, and you are generally told that it should not be given until all the signs of irritation due to the lesion which has caused the paralysis have passed off. After this you may give strychnine as a stimulant in order to make the other parts of the nervous system work more briskly, and thus supplement the function of the part that has been either totally destroyed or injured. In the case of nervous diseases where you are giving strychnine regularly, the first indication of the physiological action is that which I have just mentioned, viz., twitchings of the limbs. But there is this curious point to be noted: that the twitching begins first in the paralysed limbs. The reason of this in all probability is that the inhibitory action of the higher centres for the paralysed limbs has been destroyed. I have already told you of the answer I received from a student whom I questioned as to the first symptom that would induce him to stop administering strychnine to a patient, viz., when fits came on. This, as I said, is too late, for the patient is very apt to die quickly. However, it occasionally happens that people take strychnine either by mischance or by wilful administration, and thus fits are brought on which are characteristic. Now these fits differ from the convulsions of tetanus in this respect: that the convulsions of tetanus are tonic, that is to say, continuous, whereas those of strychnine poisoning are clonic; that is to say, they come on, last violently for a short time, then remit altogether. The patient usually dies either from exhaustion during the interval, or from suffocation during the paroxysm. The paroxysms may be brought on by any slight irritation to the patient in the intervals, such as the jarring of the floor, the slamming of a door, or any slight draught blowing upon the patient, any touch on his skin, or any touch upon his bedclothes. The treatment in a case of strychnine poisoning is to evacuate the strychnine from the stomach as quickly as possible, but of course with a man in a state of opisthotonic convulsion, in which the extensor muscles of the spine, being the stronger, bend the body backwards so as to render his aspect like that of a bow, you cannot readily evacuate the stomach. What you do is to put the patient thoroughly under chloroform, and then, keeping him under the effect of this drug, evacuate the stomach by means of the stomach tube. At the same time you may give chloral hydrate as an antidote, because chloral has the power of lessening the excitability of the spinal cord, just as strychnine has the power of increasing it. Chloral, therefore, is probably one of the best antidotes you can give in strychnine poisoning. If you can keep the patient alive so that the strychnine shall be eliminated, then he may get round, and, as you know, in cases of alkaloidal poisoning it has been proposed to flush the system out by large quantities of water, introduced either into the stomach, into the rectum, or, still more rapidly, into the subcutaneous cellular tissue, or even into the peritoneal cavity. It is still better to use instead of water a normal saline solution, which causes great diuresis with rapid elimination of any alkaloids that may be present in the blood, and you thus may save your patient.

Strychnine has the peculiarity, as I mentioned before, of being a cumulative poison; that is to say that after a patient has been going on with full doses of it for some time suddenly symptoms of poisoning may occur even when the dose has not been increased. The reason for this appears to be that strychnine tends to cause a stoppage of its own elimination by causing contraction of the renal arteries. Now, there is another drug that is also cumulative, viz., digitalis, and the same rule holds for both. If you are administering either strychnine or digitalis to a patient for a length of time, it is advisable for the patient not to go on continuously, but to go on for awhile, then stop, and then go on again. In the intervals between the times of administration the poison is eliminated, and thus you avoid the risk that would otherwise happen from accumulation.

Digitalis Group.—I went into the action of digitalis pretty thoroughly when discussing it under the head of "Action of Drugs upon the Heart," but I may perhaps remind you again that digitalis has the power of rendering the heart slower and stronger; it causes contraction of the arterioles, and raises the blood pressure. In consequence of this, more blood flows to the kidneys, the amount of urine excreted is increased, and so you get diuresis, with diminution of dropsy if it be present. Now there are certain cases in which you require to be careful about the administration of digitalis. These are cases of aortic disease in which the patient is going about, because by slowing the heart you render the patient more liable to syncope; other cases are those where the patient is suffering from disease of the blood-vessels. In cases, for example, of atheroma, especially of an advanced kind, you can readily see that if the arteries are feeble, and you raise the blood pressure, you may cause one of the arteries to give way, and apoplexy may result. A third condition is that in which the arteries are healthy compared with the heart. If the heart be feeble and fatty while the arteries are unimpaired, you can readily understand that when digitalis acts upon them, causing them to contract, it will increase the resistance opposed to the action of the heart. If the heart be to a great extent converted into fatty matter, the digitalis, although it may stimulate the heart, has nothing to work upon. The feeble, fatty heart cannot drive the blood on in face of the increased resistance, and you will make your patient very much worse, or possibly cause sudden death from syncope due to sudden failure of the heart. I mentioned to you in a previous lecture that both those ideas, the danger of digitalis in aortic disease and the danger of digitalis in fatty heart, are scouted by some men. It is quite true that in a great many cases you may go on without doing any harm, but the risk is always there nevertheless, however men may scout it, and it is well for you to bear it in mind, because undoubtedly cases do arise in which the risk has been disregarded, and bad results have ensued.

Now, what are the indications which should lead you either to lessen the dose or to stop the administration of digitalis in cases of heart disease? One of the first is loss of appetite. Digitalis seems to be eliminated by the stomach, and there to give rise to loss of appetite or even nausea, and this alteration of the stomach frequently precedes any effect upon the pulse. You may, however, find that the pulse is becoming abnormally slow. Whenever this occurs, then you know that you have obtained the full effect of the digitalis, and it is time to stop it for awhile. What I have said of digitalis holds good for all the other cardiac tonics, because their action is almost exactly the same; viz., strophanthus, erythrophlœum, convallaria, adonis vernalis, spartein, etc. The action of all these is very much like that of digitalis, the differences in their action being rather comparative than positive: that is to say, some of them act rather more upon the heart, others act rather more upon the vessels. For instance, digitalis appears to have an action both upon the heart and vessels, strophanthus appears to act more upon the heart, and erythrophlœum more upon the vessels. There are differences also in the preparations of digitalis. It contains several active principles, and these are extracted unequally from the leaf by water and by alcohol. In consequence of this, the tincture seems to be best adapted for diseases of the heart, and the infusion seems to act most powerfully as a diuretic.

Volatile Oils.—I mentioned to you before that there was another class of diuretics which appear to act not upon the vascular system of the kidney, but rather upon the kidney structure itself. These are the volatile oils. A typical example of them is oil of turpentine. The oil which is the most marked in its action upon the kidneys, however, appears to be oil of juniper, which is closely allied in its chemical composition to oil of turpentine. Oil of turpentine when applied externally acts as a powerful irritant, and it is used largely as a counter-irritant in cases of rheumatism of the joints, in cases of neuralgia and myalgia, in cases of inflammation of internal organs, such as the bronchi, and in abdominal pain depending on colic and inflammation. It has the disadvantage that every now and again it appears to bring out a rash in the neighbourhood of the part to which it has been applied. The rash varies in character, as you might naturally imagine, because the characters of the rash depend very greatly upon the amount of irritation to the tissues. You may have often a simple erythematous blush, or little pustules, or regular wheals and urticaria; you may have regular vesicles forming, and all of those may spread out from the point of application. When taken internally in large doses it is emetic and purgative, and in large doses it is much safer than in small, because its stimulant action upon the gastro-intestinal canal is such that it is quickly cleared out of the system, and very little is absorbed. When small doses are taken they act chiefly as a slight stimulant to the circulation, and as a powerful stimulant to the kidneys. The water which is passed usually assumes a curious odour; it has a smell like that of violets, and the amount of urine is increased. Doses such as 1 drachm or 2 drachms do not act as a powerful purgative or emetic, and so are often absorbed to such an extent that they damage the kidney and give rise to symptoms of inflammation of that organ as well as to symptoms of irritation of the nerve centres. The first symptom of irritation in the nerve centres is excitement, which is followed by gradual paralysis. The patient becomes soporose and comatose, and sometimes convulsions occur. On the part of the kidneys one finds the ordinary symptoms of renal irritation, viz., pain in the back, scalding in passing water, and yet, although micturition is painful, the desire to micturate is very frequent and pressing. Sometimes there is a good deal of blood in the urine, and sometimes the urine is entirely suppressed, so that the patient dies, with symptoms of coma. In cases like this, one may endeavour to wash out any of the turpentine which remains in the gastro-intestinal canal by means of bland enemata and bland fluids taken by the mouth; and also here that plan that I have just alluded to of washing poisons out of the body by means of fluid injected subcutaneously or into the peritoneal cavity might be thought of.

I have already mentioned the medicinal action of turpentine locally as a counter-irritant, internally as a purgative and as an anthelmintic. In cases of tapeworm it is given in large doses *per se*, or combined with castor oil; in smaller doses it may be employed for the purpose of acting as a diuretic. Oil of juniper has the same action, and is much used as a diuretic; oil of savin has a similar action, but it appears to have a more special action also upon the uterus, so that it tends to increase the menstrual flow, and in large doses it acts as an oxytoxic, causing contraction of the pregnant uterus and producing abortion. The same power is exercised by oil of juniper and turpentine, but in less amount, so that it is well to be careful when giving any of these drugs to a pregnant woman.

Turpentine is a good deal used internally in order to check hæmorrhage in typhoid fever. How far this checking of hæmorrhage in typhoid fever is due to the action of the turpentine I do not know. I think partly it may be due to the carminative action of the turpentine, because you can readily see that if you have an ulcer of a given size upon the interior of the intestine, and you stretch that intestine out, you will naturally tend to stretch the ulcer itself, and thus to increase the hæmorrhage, whereas, if you can allow the intestine to contract, you lessen the bleeding surface, and thus you may stop the hæmorrhage.

There are several other essential oils which have much less marked action upon the nervous system, but which are largely employed as carminatives. These are oil of peppermint, oil of cloves, oil of thyme, oil of caraway, oil of coriander. All of those oils have a chemical composition nearly allied to that of turpentine oil, but a much more agreeable odour, and are chiefly used as carminatives, for the purpose of either bringing flatulence away from the intestines or of lessening griping. They are, therefore, combined with almost all purgatives in order to prevent the pain which they might otherwise cause. There is another drug, asafœtida, which contains a volatile oil and a resin, and which has a curious action both upon the nervous system and upon the bowels. It is a powerful antispasmodic, lessening nervous irritation, calming hysterical patients, and also causing expulsion of flatulence. In many cases you have to deal with a tremendous accumulation of flatus in the bowel, and perhaps the best drug for removing this flatus is the enema asafœtidæ. It has a most disagreeable odour, and for this purpose one does not employ it if one can avoid it, but there is no drug that I know of that tends to lessen the distension of the bowel in tympanites like the enema asafœtidæ. Occasionally you may find that asafœtida, in the form of the compound asafœtida pill, is also very useful either alone or combined with a purgative in treating constipation in people who are not only constipated, but are suffering much from flatulent distension. In passing out through the kidneys some volatile oils act as a stimulus to the urethra, and they tend to relieve chronic inflammation in it. Volatile oils, when exposed to air, become partially oxidised, forming solid stearoptenes, and when still more oxidised they form resins. As they exude from trees, the volatile oils are usually mixed with resin, and are then called oleo-resins. One oleo-resin, which is very much used in cases of inflammation of the urethra, is copaiba, in the form either of the oleo-resin or of the resin, or the oil separately. It appears not only to have a stimulant action, but a somewhat antiseptic action, rendering the urine aseptic at the same time that it exercises slightly a stimulant action upon the mucous membrane of the urethra itself.

Camphor.—Camphor, which is a solid volatile oil, or stearoptene, used to be very largely employed in medicine. Indeed, it was supposed to have very marked effects in preventing infection; that is to say, people who were at that time unable to recognise the dependence of infectious diseases upon microbes thought that the application of certain drugs was likely to prevent infection, and so it used to be the fashion for physicians to go about with long canes, the upper end of which was hollow, forming a little box, the lid of which unscrewed. In this box pieces of camphor were placed, and when the physician was called to a case of infective disease he generally unscrewed the top of his cane and smelt the camphor the whole time of the consultation. I do not know that camphor really has such a powerful action as this, but it has, nevertheless, an antiseptic action, and you will find that camphor water is used in some of our subcutaneous injections for the purpose of preventing the injection from undergoing decomposition. When taken internally, it is a powerful nervine stimulant, and in small doses it seems to act as a stimulant in very much the same way as alcohol would do. Large doses tend to cause paralysis, sometimes convulsions. Cases of poisoning by camphor are not common, but it is well to remember that it is a poison, and when given in the form of enemata, for example, it may produce symptoms of poisoning, cramps, twitching, and possibly in larger doses collapse.

Ergot.—The next drug is a very powerful one, and very much used, viz., ergot. I think I might almost mention to you a curious fact: that ergot is not an insect. To most of you probably this information is quite useless, and yet, if it had fallen to your lot to look over a number of examination papers, you would have been astonished to find how often candidates stated that ergot is an insect. Others, again, instead of stating that it is an insect, say that it is the eggs of an insect deposited in the young rye, whereas, of course, you know it is not the eggs of an insect at all, but simply that the grain of the rye becomes thoroughly filled with the mycelium of a small fungus, and it is the diseased grains which constitute ergot. You can readily see that if the grain of rye be filled with fungus, two things occur, viz., that not only do you have a fungus present which has no business to be there, but you have lost the starch of which the grain ought to consist. If, then, a population be fed upon such diseased grains, not only are they getting a large quantity of the fungus contained in ergot, but they are starved, because, in place of the good grain which they ought to have been receiving, they are really getting what is no grain at all. Thus there are two processes going on. Now when rye becomes diseased, and populations are fed upon it, two results occur: the patients suffer from either (1) disease of the nerves, or (2) disease of the blood-vessels. The vascular disease appears to consist in contraction, with thickening of the walls of the vessels, so that the supply of blood to various parts of the body becomes very imperfect, and these parts undergo a process of gangrene, so that one result of chronic poisoning by ergot is known as gangrenous ergotism. In other cases the nerves are affected, and probably also the spinal cord to a large extent. Changes of a sclerotic nature take place, especially in the postero-external columns. In consequence of the affection of the nerves, we find that the patients complain of sensory dis turbances. They feel a sensation of what is termed "formication," as if ants were crawling over them. At the same time that the individual feels things which are not there, he also loses the power of distinguishing the presence of things that are there; that is to say, there is a certain amount of anæsthesia. These abnormal sensations with anæsthesia are followed by loss of power, and finally the person may die comatose.

Medicinal Use of Ergot.—These symptoms rarely occur from the medicinal use of ergot, because, first of all, we do not give ergot medicinally to the same extent as it is taken in food, and, secondly, the patients in our hospitals are well fed at the time they are taking ergot, and not starved like the poor peasantry, who are fed upon diseased rye. But even when used medicinally ergot causes contraction of the vessels, and, more than this, it seems to have the power of contracting involuntary muscular fibre generally. From its action upon the vessels, it is used in order to stop hæmorrhage from the nose, from the bowels, and from the kidneys; from its stimulant action upon the intestines, it is also used as an adjunct to purgatives. It has been said that in chronic obstinate constipation the addition of ergot to the purgatives has put the bowels into good order, and allowed them to act regularly. It is chiefly, however, for its action upon the uterus that it is employed. It causes firm tonic contraction. Now you can readily see that it would be an enormous disadvantage if the ergot were given too soon, because a powerfully contracting uterus, contracting against a resistent *os uteri* or contracting against some hard, unyielding condition in the pelvis, would lead to disaster. When the resistance is very great, and the uterus contracts powerfully, the uterus may split, and this has occurred from the administration of ergot in improper cases. Sometimes, when the cord is prolapsed, too firm contraction of the uterus may lead to stoppage of the circulation through the cord and the death of the child. As a rule one does not give ergot until just towards the end of labour, in order to cause firm contraction of the uterus after the labour is over, so that there shall be no bleeding into the uterine cavity. It is generally given now in the form of the hypodermic injection, and, instead of injecting it under the skin, it is usually injected deep into the substance of the gluteus muscle, because when used in this way it does not tend to give rise to abscesses nearly so much as when injected under the skin.

CANTHARIDES.—The next drug is cantharides. This, as you know, is the Spanish fly, and contains a substance called cantharidine, which, although it is very harmless and innocent-looking, resembling scales of white wax in appearance, is an exceedingly active irritant to the skin or any mucous membrane. When applied to the skin it causes vesication, and a certain amount of it is usually absorbed. It is employed for its vesicant powers, to lessen pain and thickening in joints. When applied to rheumatic joints, for example, it frequently lessens the pain very remarkably indeed. A strip about an inch broad painted round a rheumatic knee, just above and below the patella, will often give very rapid relief to the patient, lessening the pain and diminishing the swelling. Curiously enough, some alteration in tissue-change seems to be caused by the cantharides, because the urine which had previously been acid is sometimes found to be alkaline after a number of blisters have been applied, so that the application of blisters may be regarded as a general, and not merely a local, remedy, and may indeed be considered to be one form of serum therapeusis. It is used also as a counter-irritant in cases of inflammation of internal organs, being applied over the chest in cases of inflammation of the lung or inflammation of the pleura, nearly, but not directly, over the heart in cases of pericarditis, over the epigastrium in cases of gastric ulcer and in obstinate vomiting. It is applied in strips over the nerves in cases of neuralgia, and one common place for neuralgia to occur is in the sciatic nerve. In such patients you apply a strip of cantharides plaster over the nerve. Sometimes, oddly enough, it seems to have an almost better effect when applied over the heel of the affected leg. Why it should

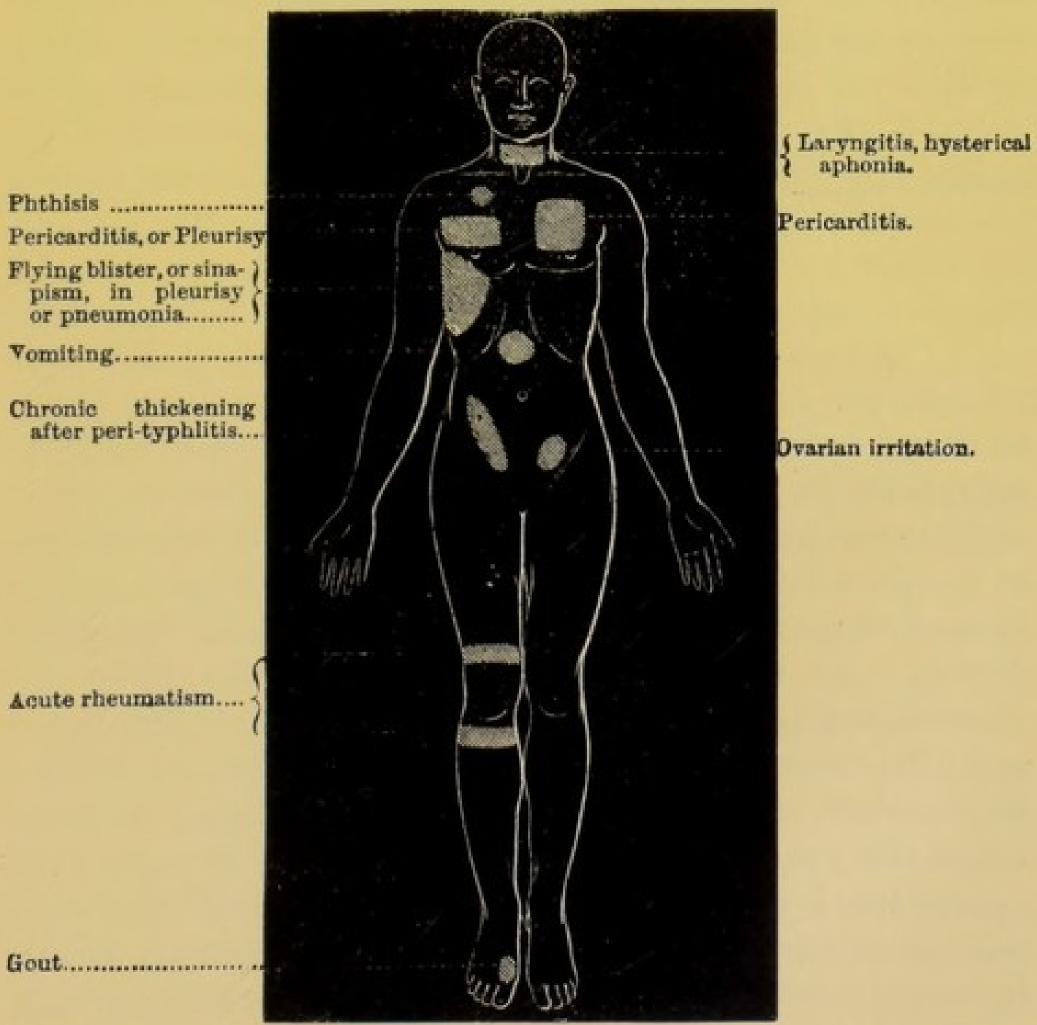

FIG. 143.—Diagram of the body showing some of the points where blisters or sinapisms are usually applied. Front view.

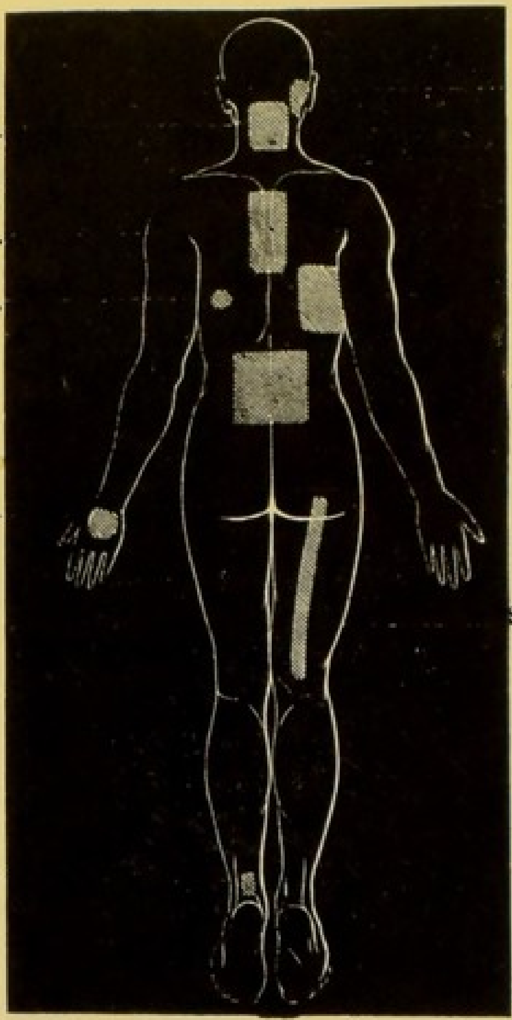

FIG. 144.—Diagram, like Fig. 143. Back view.

be so one cannot say. I mentioned before a rule which generally holds in regard to blisters: that it is advisable not to apply them immediately over the affected part if there happen to be only a little tissue between the skin and the part, so that in cases of pericarditis, as a rule, you do not apply the blister directly over the bare part of the pericardium under the sternum, but to one side or the other. The idea is that if you apply the blister right over the pericardium you may increase inflammation, and so do harm, whereas if you apply it rather to one side you may do good. How far this rule is of universal application I cannot tell. I think it is quite likely that in some cases, especially where the condition has become chronic, it would be advisable rather to apply it over the part directly affected.

Now there is a certain risk in applying blisters which you have always to take into consideration, and that is that they may not heal very readily. In consequence of this, you are very careful about putting blisters over the back of a patient who is confined to bed, because, supposing it to be a case of pleurisy or pneumonia, a sore might appear which might be difficult to heal, and which might weaken your patient at a moment when all his strength was required in order to get over the disease. Another condition in which you are careful about using cantharides is when the patients are old, because in them the healing process is slow, and there also you might get a sore hard to heal. Then you should not use cantharides over a too large extent of surface at once, lest the amount absorbed should be so large as to cause irritation of the kidneys; and in persons whose kidneys are already diseased you are careful about using cantharides at all. In such a case you may use ammonia in the manner I mentioned before. Dip a bit of lint in strong liquor ammoniæ, and cover it with a tumbler or with a watch-glass, according to the size of the blister which you wish to produce. It is a good deal more painful than cantharides, and so one would prefer the latter in most cases. Sometimes you will find that after the application of cantharides the blister does not rise very readily. In such cases, instead of leaving the blister on for a very much longer time, it may be advisable to take it off and simply put on a warm poultice. Under the influence of the warmth and moisture, the epidermis usually rises very well, and you get a blister without any further trouble.

Internally cantharides has a stimulant action upon the kidneys. It has been used in cases of leucorrhœa in 10-minim doses, and it has also an action sometimes in arresting hæmorrhage from the kidney. Curiously enough, turpentine and cantharides, both of which in large doses tend to act as powerful irritants, in smaller doses have the power of arresting hæmorrhage. Now cantharides, when given in too large doses internally or when absorbed in too large quantities from a wound, tends to cause great irritation throughout the whole of the genito-urinary passages. Like turpentine, it causes pain in the back, lessened secretion of urine or complete stoppage, the urine becomes burning and scalding, there is a frequent desire to pass water, and from the irritation in the urethra it tends to cause constant erection of the penis, persistent priapism, which is often exceedingly painful to the patient. At the same time you may get great mental excitement, the same as with turpentine; the patient may become quite delirious and afterwards quite comatose and die. The mode of treatment in a case like this is just the same as I mentioned when speaking of turpentine.

Colchicum.—This drug has an action the nature of which is not thoroughly well understood. It is not understood for this reason: that we do not understand the pathology of gout or the nature of the tissue changes which give rise to gout. It has a very peculiar action in arresting the pain in cases of acute gout. It is doubtful whether it is best given by itself or along with a purgative, but in many cases practitioners are accustomed to employ it along with magnesia, the magnesia tending to lessen the acidity of the urine, which is a common accompaniment of gout. There is no doubt whatever that colchicum lessens the pain in an acute fit of gout, perhaps more than any other drug whatever, and yet, oddly enough, many gouty patients object to the use of colchicum. They say that it gives them immediate relief, but that at the same time the after-consequences are disagreeable. A gouty man after a fit of gout usually recovers completely and feels himself ever so much better than before, and this increased health continues for a length of time, but if the fit of gout is cut short by colchicum he does not feel so well after the fit is over, and he continues below par for a much longer time. There is another disadvantage, which is that in some patients the knowledge that they can at once get rid of the pain of a fit of gout leads them to indulge more freely in the pleasures of the table, and not to exercise the self-restraint which is necessary in order to prevent a further attack, so that the use of colchicum to cut short the attacks sometimes tends to render them more frequent. Colchicum not only relieves the fit of acute gout, but is often useful in neuralgia occurring in gouty subjects. We have here in our Hospital Pharmacopœia a combination which has been found very useful for this purpose. I have mentioned before that quinine is useful in neuralgia, colchicum is useful in gout, and there is another drug which we have not yet touched upon, viz., aconite, which is sometimes very useful in neuralgia. In the following draught we have these three drugs combined:—Haustus Aconiti cum Colchico et Quinina: tincture of aconite, 3 minims; tincture of colchicum seeds, 10 minims; sulphate of quinine, 1 grain; dilute sulphuric acid, 1½ minims; chloroform water, up to 1 fluid ounce. Colchicum, I should have said, has the effect of depressing the circulation, lessening blood pressure, and rendering the pulse soft.

Aconite.—Aconite has a most powerful local action: it has the power of irritating and at the same time of benumbing the ends of sensory nerves, and it is one of the few drugs for which a physiological reaction has been introduced into the Pharmacopœia. In order to recognise aconite, we are told that a preparation of the leaves when placed upon the tongue causes tingling and numbness. When taken internally, aconite tends to cause great irritation of the vagus and to slow the heart very greatly indeed. Curiously enough, this slowing of the heart is much more marked with small doses than it is with large doses, and if you give 1 minim of the tincture of aconite in water every hour or two hours, you will bring down the pulse rate enormously; whereas if you give 10-minim doses the action upon the circulation does not seem so great. The mode of action of aconite upon the heart I simply do not understand. Twenty years ago I spent many months trying to make it out, and I failed entirely. I succeeded in getting a number of results, which I did not publish because I could not get them in any consistent form, and many other researches have been instituted by other people upon the mode of action of aconite upon the heart, and they have come to the same result; viz., that we cannot at present understand it. We do know that in small doses it slows the heart, and that in larger doses it does not seem to have this effect. On account of its power of slowing the heart very gradually, it is much used in cases of inflammation, of tonsillitis, and of rise of temperature in children or in adults with quickened pulse. In many cases aconite seems to be exceedingly useful, and by giving it in the small dose of 1 minim for an adult and a proportionately smaller dose for a child every hour, or even more frequently if you can watch the patient, you slow the pulse and bring back the patient to health. It is largely used for this purpose in many households, where when any member has caught a chill, as it is termed, and feels a little feverish, with the hand a little hot and the pulse quick, aconite is administered forthwith. A great deal of its use in households is due to the faith put in the drug by homœopaths. Aconite is by no means like most of their drugs, which you can play with as you like, because homœopathic globules consist chiefly of sugar of milk, and nothing else; but the tincture of aconite is not a thing to be trifled with at all. It has a very powerful action; and the mother tincture is, I believe, stronger than any preparation that we have in our Pharmacopœia. There used to be a tincture termed "Fleming's tincture," which was expunged from our Pharmacopœia on account of its inconvenient strength, but the homœopathic mother tincture is, I believe, still stronger. You will remember that in a previous lecture I told you of the fatal accident that befell a porter at a railway station who drank some aconite which had run out from a box which had been smashed on the platform. The symptoms of aconite poisoning are irritation of the stomach with vomiting and purging, because it is a local irritant, and associated with these there is intense collapse, the pulse becoming exceedingly feeble, the face pale and shrunken, and death occurs often with convulsions.

Veratrine has an action very much like that of aconite; and both these drugs have a powerful local action as sedatives, and are, therefore, used generally in the treatment of neuralgia or myalgia, so that the linimentum aconiti is a useful application in cases of neuralgia or lumbago. The ointment of aconite is not unfrequently used for application, not only to parts of the body, but to parts of the head, and care is necessary in its employment lest any of it should get into the eye, as otherwise it might be absorbed and produce the general symptoms of the action of aconitine. Therefore in using ointment of aconitine you take a small bit, about the size of a pea, rub it exactly on the part to which you wish to apply it, and be careful to wash the hands very thoroughly afterwards, because otherwise you may get some of the aconitine upon the hand and begin to suffer from its action, especially if you apply it to your lips. Aconitine is certainly one of the most powerful poisons we possess. In exceedingly small doses it is sufficient to kill, and $\frac{1}{100}$th of a grain would be almost certainly fatal. But you must remember that there are great varieties in the strength of the different kinds of aconite, and that what is called aconitine in the market really represents perhaps three or four different substances, each having perhaps the same general action, but some of them being very much more powerful than others. A very unfortunate case occurred some time ago in a doctor who had prescribed aconitine to a patient and gradually increased the dose. He thought he was quite certain that he knew what he was doing. The druggist's supply of aconitine ran out, and he procured some new aconitine from a different maker. This turned out to be many times stronger than the other, and the patient unfortunately became very ill. The doctor was at once sent for, and the friends blamed him for giving a drug which had rendered the patient so ill. The doctor said, "It cannot be the medicine," and, to show that this was true, he drank off a dose himself, with the result that he died. So you must be careful to remember the difference in the different preparations of aconitine.

Filix mas.—Filix mas is another drug which has been responsible for the death of a patient, and I mentioned to you before, when speaking of anthelmintics, that a printer's error led to the administration of the ethereal extract of filix mas in the dose of an ounce instead of a drachm, as it should have been. This is one of the drugs on which we rely most of all for the treatment of tapeworm, and in administering it you must recollect that it is the tapeworm that is to be dosed, and not the patient. In order that the tapeworm shall have the full benefit of the dose, you must clear any accumulated fæcal masses out of the intestine. The usual plan, therefore, is to give the patient a pill say on Friday night, and a black draught on Saturday morning. You thus clear out all the fæcal matters from the intestine. and feed him on Saturday or the greater part of Saturday upon milk only, and on Saturday night at bedtime you give him a drachm of the ethereal extract of filix mas. You make him go to bed at once, because if he sits up the drug may disagree with the stomach and be brought up. It is a local irritant, and tends to produce vomiting; but if the patient lies down and keeps quiet it will probably not cause vomiting, but will pass on from the stomach to the intestines. These being empty, the oil of male fern kills the worm, and then on Sunday morning you give the patient a powerful purgative in order to evacuate it. It frequently happens that the whole of the worm is not killed, but if you give a powerful purgative the head may be so far weakened that it may lose its hold upon the intestine and be carried away. After the worm has been expelled, you examine it in order to see if the head is present. If not present, you may repeat the medicine in two or three days, because while the head is still weakened by the first dose it is likely to be still more weakened by the second and carried away; whereas, if you allow time for it to grow and gain strength, the second dose may have no more effect than the first.

Cod-liver Oil.—Cod-liver oil is to be looked upon rather as a food than as a medicine. It is one of the best of our nutrients, and it is a nutrient not simply to the body generally, but very specially, I think, to the nervous system and to rapidly growing tissues. In consequence of this, we find that children who are strumous, as it is termed, children in whom there is a tendency to glandular swellings, thrive much better when they get cod-liver oil. It is important that the oil should not disagree. If you give it in too large quantities or on an empty stomach, it is very apt to disagree, and, like the oil of male fern, it is sometimes best retained if you give it at night just before the patient goes to bed, because then he gets to sleep; the oil remains quiet in the stomach, passes into the intestine, and is digested; whereas, if the patient sits up, he is annoyed by the gas which regurgitates from the stomach and brings with it the flavour of the oil. The dose should be from half a drachm on to half an ounce, given three or four times a day in cases where the patient will stand it.

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