PRINCIPLES OF MEDICINE:

COMPRISING

GENERAL PATHOLOGY AND THERAPEUTICS,

AND A BRIEF GENERAL VIEW OF

ETIOLOGY, NOSOLOGY, SEMEIOLOGY, DIAGNOSIS, AND PROGNOSIS.

BY

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PREFACE.

As an apology for the appearance of this publication, it may, I think, be stated to be generally acknowledged, that there is at present no work which fully treats of the subject of General Pathology, and its application to practical medicine. The present attempt to supply the defect arose from my feeling the want of an elementary work on these subjects, by aid of which I could introduce to my pupils the science of practical medicine. With many excellent and elaborate treatises on the details of medicine, we have scarcely any which treat of those general principles in the nature and treatment of disease, which are really fundamental in the practice of medicine. Even the very able work of my distinguished friend, Professor Alison, (to which the following pages owe much,) in the last edition, instead of some of these general principles, embraces some of the details of Special Pathology.

It may be supposed, that in subjects comparatively so modern as those embraced in this work, little reference can be made to any but recent authors; and for a great portion of the facts and illustrations, I have drawn on my own experience in the continual observation of disease, during upwards of twenty years, in hospitals and private practice. Throughout this experience, I have always endeavoured to keep in mind the bearings of physiology and pathology on practical medicine, and to render their advances useful, by their application to this art. Many original facts and opinions have been the result of this mode of study; and some of these will be found in the following pages. I cannot expect that they will speedily receive a general assent; but I ask for them the test of clinical observation, from which they have been mainly derived.

It seems quite extraordinary that, notwithstanding the recent rapid improvements and comparative perfection of the contributory sciences, practical medicine should still halt in the domain of empiricism. A chief reason for the anomaly seems to be, that science and practice have been rarely pursued by the same parties. Scientific men are not and cannot be practical, because they have had no experience; and practitioners know little of science, and therefore derive little good from it. Instead of working together, these parties are at issue with each other. But it is high time to put an end to this feud. Philosophers must descend from their transcendental positions, to consider the details of practice and purposes of utility. Those who would be practitioners, must gain from science that knowledge and that method which render experience instructive and useful.

In the present effort towards the accomplishment of these objects, I am conscious of many deficiencies. Want of time has prevented me from treating some subjects as fully as they deserve, particularly those of the last chapter. In others, I have studied to be brief, to avoid perplexing the reader with much discussion or detail. For this reason, doubtful facts and a variety of conflicting opinions have been withheld; and only the facts best ascertained and the views which seem most tenable have been given. By this eclectic method, I have succeeded in reducing a very extensive range of subjects within the compass of a moderate volume.

7, *Holles Street, Cavendish Square,*
22 *Sept.* 1843.

PREFACE TO THE AMERICAN EDITION.

A work on General Pathology supplies an actual want in English Medical literature. Dr. Williams is so favourably known in this country, more particularly by his treatise on the Diseases of the Chest, that his name is almost a sufficient guaranty for the excellence of the present work. These expectations will not be disappointed. Owing to the want of time on the part of the Author, several subjects have not been fully treated of. To supply these omissions has been the endeavour of the American Editor. The chief additions will be found in the Sections on the Blood, on Diagnosis, and on Prognosis. A chapter on Fever, and one on Hygiene have also been added. The new matter is distinguished thus [—C.]. The Editor must here state his acknowledgments to the works of Professor Alison,* Chomel,† and Andral,‡ to which he has had occasion to make frequent reference.

M. C.

* Outlines of Pathology and Practice of Medicine. By William Pulteney Alison, M. D., Edinburgh, 1843.

† Elémens de Pathologie Générale. Par. A. F. Chomel. Paris, 1841.

‡ Essai d'Hematologie Pathologique. Par G. Andral. Paris, 1843.

230, *Spruce Street*,
22 *Nov*. 1843.

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CHAPTER II.—PATHOLOGY (PROPER) OR PATHOGENY.

ON THE NEED OF THE STUDY OF

GENERAL PATHOLOGY,

AS THE FOUNDATION OF PRACTICAL MEDICINE.

Extracted from an Introductory Lecture on the Principles and Practice of Medicine, delivered at University College, Oct. 1, 1842.

[The following remarks may serve as an introduction to the present work, as they were intended to be introductory to that part of the course of lectures which embraces the same topics. As an apology for the familiarity of their style, the reader may be reminded that they are printed as delivered.]

State of practical medicine, as a study, and as an art—Insufficiency of empirical and nosological medicine—General pathology the true foundation for practical medicine —What is general pathology?—Its relations to clinical medicine—Noble nature and objects of medicine.

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I must further state another circumstance which greatly upholds my anxiety to bestow my best exertions in teaching the subjects of my course. It is, *the low position which this most important part of medical science still holds with the public, and even with students.* I feel this to be a matter of such moment, that I propose to make the chief subject of this lecture, the state of practical medicine, as a study, and as an art.

Compare the state of the practice of medicine with that of anatomy, phsyiology, and chemistry—the great fundamental or preparatory studies. How minute, how precise, how connected and definite are these! Yet how loose, indefinite, uncertain, unconnected, is the practice of our art. To the public it appears altogether vague—without any acknowledged principles.

Is there any wonder, then, that quackery should triumph?

that the public show their want of faith in legitimate medicine by their ready belief in any novelty that is not legitimate? Thus, one year, St. John Long's plan; another year, homœopathy; another, Morison's pills; another, the water-cure — rules the fashion. The public may show their ignorance by such credulity; but they show also the want of something plain and trustworthy in regular medicine. The public will not believe that the secret of the art is with a faculty which professes to follow experience only. The quack also can appeal to his experience; and that, too, in a way more striking and convincing than those who express doubts and admit difficulties. Thus, one who cures nervous diseases can calculate his success by the numerical method. In eight thousand cases he can count only twenty failures. Another tells you of an extraordinary per centage of success in cases of deafness, in which the *most eminent practitioners had failed*, &c. Hence you will find the partisans of quackery far more zealous in the defence of their favourite notions than others are in support of the regular art. No wonder that homœopathy and the water-cure have their royal and noble advocates. Then there is a captivating simplicity in the theories of quacks. A certain high official personage pins his faith to an empiric who was formerly a gardener, and whose notion is, that all diseases proceed from buttercups. This is the theory: every man, woman, and child, eats mutton, beef, or butter, or drinks milk: every cow and sheep eats buttercups with its grass; buttercups are rank and acrid weeds; *ergo*, all diseases proceed from buttercups. How beautifully simple! How attractive, too, are the comprehensive views of the hygeist and the water-curers! They both agree in their pathology; all diseases arise from bad matter in the blood; they only differ in their mode of expelling it from the system. One purges out the peccant humour; the other washes and sweats it forth. There is something, too, very fascinating in the notions of homœopathy: *similia similibus medentur*. Who cannot fail to admire the expansive genius of Hahnemann, who discovered that the best cure for a disease is the influence which caused it?

On the other hand, the regular practitioner has nothing so plausible or so captivating to bring forward in explanation of *his* method. He has either no theory at all, and grounds his practice on experience, (in which we have said he is matched by the empiric,) or, if he gives a theory, it is viewed only as an opinion no better than the hypothesis of the quack, in an art so little founded on principles as medicine. So little favour does medicine receive from the public in its pretensions to science!

How is it with the student? Surely to the student the practice of physic must be as interesting as it is important—the useful application of all his knowledge—the winding-up of the drama of his studies—the rehearsal of the great performance of his life. Surely this must be a very attractive study? Quite the contrary. I believe it has been generally considered by students as the heaviest, most repulsive, most tedious of all subjects, (with, perhaps, a single exception.) Without the constant appeal to the senses with which *anatomy* attracts and rivets attention; without the beautiful connections and adaptation of means to ends which make *physiology* interesting; without the simplicity and striking phenomena which give a charm to *chemistry*—the practice of medicine, as taught, is an enormous mass of dry detail; its science, mere glimpses into an unknown land; its rules, irregular tracks through a wilderness of confusion. Practical medicine is studied only from a conviction that it is useful and necessary; and not because it is easy or agreeable.

Further, there are a great many students, certainly not the most industrious, who shirk the disagreeable duty, pleading that it is neither useful nor necessary; and that the practice of medicine is only to be learnt at the bedside with whatever aid books can supply. It would speak more in favour of this opinion, if its advocates acted up to their dogma, and proved, by their constant and diligent attendance in the wards of the hospital, that they seek there the knowledge which they profess to be unable to obtain in the lecture-room. But, so far as my observation has gone, I do not find this to be the case. It is not those that neglect the lectures, but those who most regularly attend them, that prove to be attentive students in the hospital.

But, although useful and necessary, it cannot be denied that the study of the practice of medicine, both by books and by lectures, is at first very difficult and irksome—more so than other studies. But why is it so? This is a serious matter. Let us examine a little into it. Is the fault in the imperfect state of the subject, or in the method by which it is taught? The science of practical medicine is undoubtedly very imperfect; but I think it can be shown that there is a still greater imperfection in the method by which it is taught.

As anatomy and physiology, with chemistry, are the studies preparatory to medicine, one might expect that they should be made fundamental to that of medicine; that, starting from the knowledge of the healthy body, as taught by them, the transition should be easy and intelligible to disease—first, in its lowest degrees and simplest form; then to that which is more compound, pronounced, and more removed from, but still comparable with, the healthy standard. Instead of this, lecturers and writers plunge at once into the mazy thickets of inflammation and fever—subjects so complicated, so changed from any thing taught by previous study, that anatomy and physiology afford little help: and no wonder that the student (like many observers and reasoners on the same topics) becomes confused and bewildered in the complexity of the subject; or, if he do make out any thing, it is something isolated, abstract, about fever or inflammation itself, without its natural relations to health and to other diseases.

This plan of proceeding may be compared to a person beginning the study of mechanics with the steam-engine; or to the student of chemistry commencing with organic matter.

The general result is, that where any distinct notion of disease is acquired, it is one not at all founded on previous physiological knowledge, but it is a new idea of disease as an absolute separate thing—not a mere condition consisting of altered function and structure, but a being, the character and history of which are to be detailed like that of a plant or an animal. And when special diseases are treated of, the same individualizing process is pursued through all the jargon of the schools. Each has its nosology, classification, and definition; its predisposing, exciting, and proximate causes; its theory, *ratio symptomatum;* its diagnosis, prognosis, indications of cure, fulfilment of these, *juvantia et lædentia*, and prophylaxis!

With all this formidable array to each disease, the practice of physic was an arduous study in the days of Cullen. What must it be now, when the diseases of Cullen's nosology have been almost doubled, and the facts relating to them have been more than doubled?

But let us follow the student, well crammed with his nosological list, their definitions, &c., to the bedside. Let us see how his knowledge, so meritoriously and laboriously obtained, will serve him in the hour of need. In a few cases of fully developed and well marked acute diseases, such as pleurisy, scarlet-fever, or rheumatism, he may get on pretty well; but in the commoner description of cases, acute or chronic, in their early stages, in their endless variations from peculiarities of constitution or from complicating causes, he find himself continually puzzled: the phenomena do not correspond with any of his defined diseases; they frequently change their character in a way that he cannot account for; his prognosis is falsified; his diagnosis fails; and his treatment, although not always unsuccessful, does not answer according to his expectations; some patients recovering whom he expected to die; others dying, or not improving, whom he expected to recover.

Disappointed in the failure of his nosological learning, the young practitioner more and more mistrusts it, and falls into a routine of empirical practice. Without troubling his head about the name or nature of diseases, he thinks solely of their treatment; and, begrudging the time that he has spent with books and lectures, he decries every thing that is not practical.

Still he is obliged to retain some notions of the theory of disease; but they are general notions, and not fettered by definitions. He still studies symptoms: he seeks in the pulse and heat of skin indications of fever and inflammation; he looks to the tongue and alvine evacuations for proofs of disorder of the digestive organs; he judges by the complexion and muscular strength the state of the constitution. Instead of troublesome scholastic definitions, he uses convenient, general terms, which may be taken in a pretty vague sense—such as irritation, congestion, constitutional weakness, cachexia, disordered digestive organs, scrofula, scorbutic habit, and the like; and his remedial measures are designated in the same convenient general terms—such as soothing, cooling, supporting, stimulating, alterative, purifying, &c.

In short, he has, in practice, learned himself, in a loose way, at the expense of previous studies, and sometimes, it is to be feared, at the expense of some bad practice, what he ought to have been properly taught as the foundation of his studies—*general pathology*. Thus we are led to the presumption that general pathology is the proper basis for practical medicine; and I venture to affirm, that a chief reason why the practice of medicine has been commonly so distasteful, and so difficult in its study, and so unsatisfactory when tested at the bedside, is, because its foundation, *general pathology*, has not been efficiently taught.

We have just met with a practical illustration of the truth, that general pathology is a more efficient help at the bedside than such knowledge of diseases as is to be obtained only from nosological definitions and details. Before I proceed to exemplify this truth, by matters of every-day experience, let me first briefly point out why it is so.

Without the connecting link of general pathology, practical medicine derives little or no aid from anatomy and physiology. Instead of being founded on them, it is studied and practised quite independent of a full knowledge of them, and is generally acquired in proportion as they are forgotten. This kind of practical medicine is much the same as that of old women and nurses; it consists chiefly of treating symptoms, or groups of symptoms, (called diseases,) by remedies that have been found useful in similar cases, without the trouble of inquiring about the causes of the symptoms, or the precise seat of the disease. Thus, if a person complains of headache and giddiness, leeches are applied, and purgatives are given, because they have been found useful in similar cases. An intimate knowledge of the structure and functions of the contents of the head would give no further help in the use of these remedies; nor suggest others, if these be found to fail. If they do fail, the only resource is in experiment: first one thing is tried, then another, until much mischief may be done, or at last, perchance, the right remedy may be hit upon; and this may be the very opposite of those first used. Long experience may make the symptom-treating practitioner more successful, if he be an observing man; because it will acquaint him with additional symptoms to be considered for the guidance of the treatment. But there are few of this class of practitioners who are carefully observing men, who do remember and profit by their experience: they more generally, like their sisters, the nurses, keep pretty close to their first notions; and although age and the name of experience may screen *their* failures, alas for the young adventurer who sets sail on this tack!

But the benefit of such experience is gained at the commencement by the student of pathology. He has learnt to trace symptoms to their causes. Having been taught, by anatomy, the peculiarities of the circulation in the head—and by physiology, confirmed by clinical observation, that this circulation may be similarly impeded by opposite causes, inanition as well as fulness, —he is prepared to find out, through other symptoms, which is the cause of the headache in the case before him; and he adapts his remedies accordingly.

In fact, a true pathology, or sound principles of medicine, is the embodiment of the result of experience in disease, with a knowledge of structure and function in health. It is the only connecting link between the preparatory sciences and practical medicine. *Without* it, these are *disjecta membra; with* it, they form a connected body of science—young yet, it is true, and falling short of the objects of the art, but already available for much, and needing only the growth and continued support of its chief members, especially anatomy, physiology, and clinical observation, to become the perfect and efficient director of practical medicine.

The great proof of the practical utility of general pathology is, the aid which it gives in the study of clinical medicine, and the light which clinical medicine continually throws on it. The states which the practitioner has to treat are often too indefinite or too mixed to correspond with any of the definitions of special disease. They frequently consist of functional disorder, varying with time and circumstance, or changing its place, so as to present no fixed characters. But, compared by the pathologist with the standard of health, and analyzed from their complexity, their nature becomes intelligible, and their proper treatment obvious, so far as means are possessed to counteract or control that which is wrong. Let us take one out of many examples. The disordered state of health, for treating which Mr. Abernethy gained such a reputation, is one of the commonest ailments we have to prescribe for: some call it, with Abernethy, "all stomach," others, "liver;" others, "disordered constitution;" others, "indigestion;" but however differently they may name it, few refuse to treat it, as Abernethy did, by regulated diet, blue pill, and mild saline aperients, repeatedly administered. Now, the pathologist analyzes the symptoms of such a state, and in the white or yellowish furred tongue, morbid eructations, tender epigastrium, sometimes full right hypochondrium, with extended dulness on percussion, the discoloured fæces, the high-coloured and turbid urine, he finds proof of congestion and disturbed secretion of the liver and upper part of the alimentary canal; and he recognises in the remedies employed, means which, by increasing the secretions, relieve the congestion; and if these fail, he can suggest other measures which he knows to be efficacious in removing congestion, and restoring the natural secretions. Again, what confusion in diagnosis, as well as in practice, has arisen from comprehending, under the specific name *hysteria*, the most opposite and most varying conditions, merely because they are consorted with some nervous phenomena; so that this word becomes almost synonymous with *female diseases*. But, pathologically considered, the confusion in diagnosis, and, in some measure, the perplexity in regard to treatment, cease. In one group of such cases, the pathologist finds really such signs of disordered *uterine* function as would justify the name; other symptoms, however varied, taking their origin from this disorder; and he thus discovers the necessity of directing the treatment to this cause. In another group, again, he finds the uterine function impaired; but this only in common with other functions: and all this in consequence of a *want of blood* throughout the body, which want is denoted by the waxy complexion, the pallid lips and gums, the loose yet easily quickened pulse, the panting breath, the feeble limbs, &c. Here the restoration of the blood is the obvious indication; and in proportion as this is effected, the symptoms of nervousness, debility, and loss of function, disappear. In a third group of cases, called hysterical, the pathologist discovers the opposite condition, that of *sanguineous plethora*, which, independently of any disorder of the uterus, causes trouble, sometimes in one part, sometimes in another, but especially in the nervous system, which, in most females, is peculiarly liable to disorder. Here, too, he is led to the most appropriate treatment.

This is but one instance out of many that might be adduced to show the great practical utility of a good knowledge of pathology. In fact, the leading rules of practice, those which guide the most experienced men, (although many are not aware of it, and would not acknowledge it,) *are* founded on general views of diseased function and structure—that is, *general pathology.* You will not find that practical men treat a disease merely according to its name, or according to the nature of the local mischief. Inflammation is not always to be combated by blood-letting, nor hæmorrhage by styptics. The condition of the system —that is, of the functions, is to be taken into account; and the variations of this condition, the states of sthenia and asthenia, tone and debility, excitement and depression, plethora and anæmia, are the very subjects which general pathology explains and shows how to treat.

I say, practitioners *do* act more on general ideas of disease than on their knowledge of particular diseases. They feel the pulse and the skin, to guide them in the use of blood-letting, whether they have found out the special disease or not. They examine the tongue, and inquire as to the state of the evacuations, to guide them in the use of purgatives, under whatever complaint the patient labours. They consider the complexion and bodily strength in connection with dietetic measures; and the chief treatment of convalescence depends on rules suggested by general pathological knowledge.

There are other very important departments of medicine which are comprehended in general pathology, and with it have been too much neglected—I mean, the study of the causes of disease and their modes of operating on the living body, (*etiology*,) and the means by which they may be avoided or counteracted, including *prophylaxis*, or the prevention of disease; and *hygienics*, preservation of health. Neither of these subjects can be satisfactorily comprehended without a sufficient knowledge of the elements and laws of disease.

Is it not, therefore, most important that these general views, which are so practical and so extensive in their application, should be well founded and carefully studied? Is it right that the leading doctrines of disease,—leading not in theory but in practice, —should, as hitherto, be left to be picked up irregularly, from casual retrospects of study or experience, when they may be learned as the very groundwork of practical knowledge?

What, then, is this GENERAL PATHOLOGY, which we extol so much as the proper foundation of practical medicine? Let us first state what it is not. It is not a collection of hypotheses hung on solitary facts, and ingeniously devised to explain this or that symptom, or the *modus operandi* of this or that remedy. It is not any thing floating on (I cannot say, founded on) conjectural notions in anatomy and physiology, such as the existence and circulation of a nervous fluid, the presiding influence of the ganglionic system, or the vital attractions and repulsions of the circulating fluids: notions which, however they may hereafter be substantiated, are at present too speculative to form a foundation for pathology. Nor is it a partial set of opinions, erected on *one* only of the many pediments of fact on which the science of medicine should stand. Healthy anatomy, physiology, physics, chemistry, the study of clinical medicine, that of materia medica, morbid anatomy—neither of these *alone* can furnish a foundation for pathology—that foundation must be formed by ALL—the facts which all supply constitute the material of which it is built, and the general facts or laws of all must be brought to bear on the arrangement of these materials in the construction of a system of pathology.

Some advancement in these contributory departments is necessary before the work can be begun, and it is because they *have* advanced that the opportunity is afforded. Why should the science of medicine remain in a state of powerless infancy, when its members are progressively acquiring strength and maturity? Why should the art of medicine still be a groping about in blind empiricism, and an unintelligible confusion of facts, when science even now can afford it the beginnings of light and of order?

I have just said that the contributory sciences are sufficiently advanced to be generally applicable to practical medicine. The proofs of this in detail will, I trust, appear in the progress of the course; but I will adduce here a few examples of a prominent kind. Disease, in so far as it is the result of *mechanical* change, or in part made up of mechanical elements, may be properly treated by *mechanical* means. It was the knowledge of this fact which led Dr. Arnott to invent that admirable contrivance, the water-bed, by which disease is often prevented and removed; and he has lately made another application of physical science, in modes of applying pressure to parts with such equality as to control to any degree the circulation of the blood through them, and thus to relieve pain, remove congestion, subdue inflammation, heal ulcers, disperse swellings, and arrest the growth, if not to effect the removal, of tumours and other morbid productions. Disease, so far as it is physical in its nature and in its effects, is to be investigated by physical means. Hence the advantage of acoustic science in assisting us in diagnosis of internal disease, and of optical science in enabling us to witness the minutiæ of its operations and its products. I need scarcely add, that the treatment of disease is in some instances founded on, and in most cases guided by, knowledge thus obtained.

As an example of improvements in *anatomy* and *physiology* bearing on practical medicine, I may mention the late researches on the nervous system, and especially those of Dr. Hall. By these, much that before was unintelligible in diseases of the nervous system has been satisfactorily explained, and their diagnosis and treatment have received proportionate aid. Considerable light has been thrown on diseases of the liver and of the heart, by recent anatomical and physiological investigations of these organs.

The aids afforded by *chemistry* to the materia medica have been long acknowledged, and continue to increase: but chemistry is growing in importance in its applications to every department of practical medicine. It is now directly useful in the diagnosis and treatment of diseases of the urinary organs. It furnishes a key to the most important rules of diet, in health as well as in disease, and bids fair to supply much that is wanting in explanation of the origin of many maladies, and the most direct mode of preventing them. It is through the aid of organic chemistry, now far advanced—advanced, too, mainly by the labours and genius of an illustrious chemist, who this day honours us with his presence, (Professor Liebig)—that we may hope that experimental physiologists and clinical observers will be enabled to solve some of the dark problems of the operation of medicines; a subject replete with practical importance, yet one that still lies chiefly in the region of conjecture.

It will not be disputed that *clinical observation* has lately done much for the advancement of the science of medicine; and this not only because it is the test by which the contributions of other branches are tried, but also because in itself it is carried on with the minuteness and precision which are essential to science. This precision must apply, not only to the modes of calculating facts, but also and most particularly to the correct determination and classification of these facts. The accuracy of counting is a mere facility in common arithmetic. The accuracy of observing and arranging the facts to be counted is the higher and rarer quality. Both are required in the prosecution of clinical research.

The whole department of practical medicine teems with examples of the benefits which it has derived from *morbid anatomy.* What should we know of the nature, products, and tendencies of inflammations, and other diseases which alter the structure, but for the scalpel revealing them to our very sight and touch? The minuteness with which it (morbid anatomy) has been pursued in connection with clinical observation, in regard to diseases of the lungs, heart, liver, kidneys, and alimentary canal, deserves especially to be mentioned as the great source of our improved theory and practice in these complaints.

It is not a general or superficial knowledge of any of these fundamental sciences that will avail to make them profitable to medicine. It is where their facts and laws have been carefully studied, in relation to the living body, that the advantage has become practical; and this study has in many instances developed new phenomena, which reflect light also on the contributory science. The application of hearing to the distinction of diseases has given rise to a more intimate knowledge of acoustic science. Some of the most interesting facts and laws of organic chemistry have resulted from researches instituted with reference to the investigation of disease; as, for example, those of Prout, Wohler, and Liebig. In regard to anatomy and physiology, the instances are abundant. For example, the researches of Charles Bell, Foville, and M. Hall, on the nervous system, and those of Astley Cooper on the testicle and mamma, were conducted with express reference to diseases of these organs, and were often suggested by the knowledge previously possessed of these diseases. In this respect they followed John Hunter, who throughout his anatomical labours had an eye to pathology, and by observing disease was continually guided to objects for these labours.

So we shall find, as we proceed to the details of pathology, that subjects which require further research are continually presented to us in a practicable form; and I shall take occasion to point out some of these, in the hope that some among you may be induced to cultivate ground which is rich in promise of important practical results.

Do not suppose, because I insist strongly on general pathology being the proper basis of practical medicine, that this will lead us to neglect the superstructure, *special pathology*. Individual diseases will be the chief subjects of the course, occupying 100 out of 130 lectures; and I trust that their details will become much more comprehensible by the arrangement into which general pathology will enable us to distribute them. It is because I feel the vast importance and extent of our knowledge of individual disease, that I would endeavour to introduce you to it from the most advantageous and commanding position; and that position is afforded by a previous acquaintance with the general features of disease. In fact, individual diseases are like the leaves and boughs of the tree, of which general pathology constitutes the trunk and great branches—all preserving an identity and connection, yet each portion having peculiarities of character which require separate study. Or medicine may be compared to a great edifice, the foundation and great entrances of which represent pathology, which generally give the proper approach to the separate rooms, special diseases. To some of these, in the imperfect state of the structure, there may be access only by the dark back ways of blind experience, which there must not be neglected; but this is no reason for making these *dark back* ways the only entrance.

Throughout our examination of the details of disease, we shall find the principles of general pathology continually exemplified; and through these principles the mind can master the details to an extent wholly unattainable by those who pursue them as unconnected matters of fact. Those who begin the study of practical medicine by attempting to learn the details of diseases, are like those who would endeavour to master all the facts of chemistry without any knowledge of the general facts or laws of chemical action, affinity, and definite proportions; yet even in practical chemistry, or chemistry applied to the arts and manufactures, the most extensive and important services have been obtained from these very principles, applied to the details.

But in treating of individual diseases, although we shall find our previous pathological principles of great use in explaining and simplifying the details, we are not to be tied to them whensoever experience varies from those principles, or goes beyond them; there, experience must be carefully followed. There is no subject in which this simple statement of fact is more frequently necessary than in regard to the *modus operandi* of medicines. It is quite true, that many curious speculations have been offered on this subject. In fact, it seems to be quite the hobby, or the Pegasus, of a very speculative class of men who call themselves practical. These can tell you to a nicety how mercury cures syphilis; how opium causes sleep; on what precise parts of the intestinal tube each variety of purgative acts, &c. But, as in most of such hypotheses, there is much more of fancy than of fact; and as the fancy, if erroneous, may be mischievous in a strictly practical matter, I shall be excused if I prefer giving you the naked matters of fact.

The purpose of lectures on the practice of medicine is not merely to convey knowledge of disease and its treatment, but also to direct the mind in the ways of using this knowledge, and of acquiring more. Books will supply details which cannot be given in the lectures; but the more important additional source of information is *clinical instruction*. This is an essential part of the teaching of practical medicine. It is its demonstrative part, and is essential, not only because, like other witnessed phenomena, it appeals to the senses, but also because it is necessary to practise those senses in the examination of the signs of disease, and to exercise the reasoning powers in the interpretation of those signs, and in the further application of previously acquired knowledge. As general pathology is the connecting link between the preparatory studies and practical medicine, so clinical instruction is the step between the knowledge of medicine and the personal application of that knowledge in actual practice. I need not say that each of these is most necessary to the formation of a good practitioner: but there are especial reasons why clinical study, connected with the practice of medicine, is more indispensable now than it ever was. In former days, medicine was little more than a matter of routine; and the examination of a patient was summed up in feeling the pulse, looking at the tongue, and asking a few questions as to the feelings and functions, and this was often done for the sake more of form than of information; for the pills and draughts were much the same in most cases. This was little better than quackery, and required no great preparatory study. That it sometimes succeeded to win the favour of the public is not surprising, seeing that quackery often had a similar or greater success. Then the ignorant practitioner could disguise his emptiness by a cloak of mystery, and a solemnity of manner, and could command confidence by dropping a hint about his experience, tact, and intuitive perception of disease. But, ignorant as people still are in medical matters, they are not so dull as to be deceived by these means. They have a smattering of physiology and the use of remedies, and they are become troublesomely inquisitive; and if they are taken in, it is by the clever quack, who is ready with his theories and persuasive proportion of cures, and not by the unsatisfactory regular, who examines but little, and cannot explain his views or his practice. In short, the public look for what they have a right to expect, thoroughly educated practitioners, who prove their qualifications by their careful method of investigating disease, the clearness with which they give their opinions, and the general correctness of those opinions.

This, then, is another reason for thoroughly availing yourselves of practical instruction, especially in the clinical department. The great importance of this department has occasioned the adoption of extended measures for teaching it. I trust that you will prove, by the assiduity and success of your practical studies, that the college has not adopted these means in vain; but that, as in the preparatory branches, so in the finishing of your medical education, you will obtain that high standard of qualification that must insure the confidence and esteem of those among whom you may exercise your calling.

Gentlemen, we have great pleasure in meeting you again for the session—those who have favoured us before, as old friends; new-comers we welcome to the work, which, although arduous, is not one of drudgery. I almost envy the pleasure, in young and ardent minds, of rising step by step in knowledge, and delighting in the wonders and beauties of the enlarging view. I admit that the ascent is arduous—that it requires hard labour, and no little self-denial. But is there no compensation in the delight of acquiring knowledge and intellectual power? No gratification in learning and contemplating the intricate beauties of the most perfect part of the creation? Is there no moral and religious good to our own minds in tracing out and unveiling its frailties, weakness, decay, and death? No satisfaction in learning of means which a gracious Providence supplies for preventing and removing the ills which flesh is heir to; for relief of pain, suffering, and weakness, and restoration of health and strength? And if from present studies you carry your anticipations onwards to their final object in practice—under heaven, yourselves to ease suffering humanity, and to invigorate and prolong life—is the pursuit less noble, or less worthy of your highest thought? Need I say more for the intellectual and moral greatness of our art?

Is a study noble in proportion to the breadth, and depth, and diversity of the knowledge on which it is founded? Then, think of medicine; how she levies her contributions from every branch of knowledge. The human body exhibits a machinery so perfect, that the most skilful mechanical philosopher may take lessons from studying it. It contains a laboratory so diversified, and chemical processes so subtle, that therein the ability of the most expert chemist is far surpassed. But the knowledge of the student of medicine must go beyond that of the mechanical and chemical philosopher. He must study those vital properties, of which they can tell him nothing. He must become acquainted with the attributes of life operating in matter. In animal generation, nutrition, growth, secretion, motion, and sensation; in the variations of these processes, in their decay, and in their cessation, which is death, he has a complicated study, peculiarly his own, in addition to those of a more elementary nature. He has, besides, to contemplate the body under disease, and to bring to his aid the three kingdoms of nature, and almost every art and every science, for agents and means to counteract and control that which disturbs its well-being. But is the body the only object of his care? No. Mind and matter are too closely combined to be studied or treated apart. To medicine alone it belongs to contemplate and to treat the ENTIRE MAN—PHYSICAL, MORAL, AND INTELLECTUAL. What can I say more of the intellectual greatness of our art?

Neither shall I strain your thoughts far to remind you of its moral worth. See its effect on masses of mankind, displayed in the progress of the happy discovery of Jenner! See how even barbarous people and idolators, Mussulmen, Hindoos, and Chinese, respect our nation only for the medical aid which it can supply. So that it has happened that medicine has become the handmaid of religion—a bond between countries, a peace-maker between nations.

But let us not vaunt ourselves. Listen to one who speaks of our art—and that one the eloquent ambassador from the United States, the Honourable Edward Everett. I quote from the *Times* of the day before yesterday:—"For what was that which constituted the chief pride and glory of the British nation? They had heard of the intercepted letter from one Chinese chieftain to another; and what was the characteristic which had excited the admiration of the mandarin of a great and important empire, reeling at the time under the blows of the British government? Was it the military prowess of their countrymen? Was it the steam-vessels of war reaching coasts in defiance of the desolating simoom? Was it their arms—their artillery—their skill of engineering, which civilized nations now brought to the strategy of war? Was it this, or any of these, which had struck with wonder, and awe, and admiration, the barbarians of China? No! It was the humanity of British physicians and surgeons—their management of hospitals, and the generous kindness which was extended to the sick and wounded, even of a hostile nation—which moved them with astonishment, and excited their sympathy and regard. These were some of the arts of peace which extorted the admiration of an enemy, and which other states would do well to imitate."

But if you would see the moral influence of medicine depicted in its liveliest hues, I would ask you to contemplate a domestic scene—a family whose hearts are wrung with a dreadful anxiety for one vibrating between life and death. What a ministering angel does the physician seem! How they watch his every look! With what breathless earnestness do they hang on his words! and those words, how they wing themselves to the souls of the hearers for sorrow or for joy! Yet such scenes are passing daily and hourly in every class of society—in the mansion and in the cottage: they open the hearts of all; for the moral influence of medicine is bound up with the treasures of life and health, and with all those endearing ties that make these treasures doubly precious. Nay, how often, with the hopes, or fears, of a blessed or an awful eternity!

Do not think me too enthusiastic, nor that I overrate the profession you have chosen. Morally and intellectually I cannot overrate it: and now, at the commencement of a new epoch of your studies, when toil and exertion are required, I would cheer and encourage you, by reminding and convincing you of the intrinsic gratification which these studies may afford, and of the nobleness of the objects for which they prepare you.

It is the fashion to decry our profession—to call it a poor profession, a degraded profession. If it be poor and degraded, is that the fault of the calling, or of those who practise it; or rather of those who should have governed and protected it? Is the art of healing in itself less noble, because its practitioners, unsupported by the arm of civil power, and too often unsustained by a consciousness of their own dignity, have not raised it to the place in society which it ought to hold? Poor it may be, but degraded it cannot, shall not be, so long as its foundation is science, and its end the good of mankind.

PRINCIPLES OF MEDICINE.

EXPLANATION OF THE SUBJECTS OF THE WORK.

1. The Principles, Elements, or Institutes of Medicine comprise those leading and general facts and doctrines regarding disease and its treatment, which are applicable, not to individual cases only, but to groups or classes of diseases. The same branch of medical knowledge is also designated by the term General Pathology and Therapeutics, to distinguish it from special pathology and therapeutics, or the theory and practice of medicine in relation to individual diseases.

2. The principles of medicine may be deduced in part from a knowledge of animal structure and function, anatomy and physiology, conjoined with an acquaintance with the agents which cause and remove disease; but chiefly they are derived from a generalization of facts observed in an extensive study of disease itself, and its effects, in the living and in the dead body. But so far as they have been ascertained, they become more intelligible to the student if explained synthetically, by first describing the causes of disease, then their operation on the body, and lastly, the resulting changes in function or structure which constitute disease in its more elementary forms.

3. Etiology, or a knowledge of the causes of disease, will introduce us to their effect—*disease;* the nature and constitution of which will then be considered under the head of pathogeny, or pathology proper. As this last subject is the chief one to be treated, it will form the greater part of the work, and it will be combined with such an elementary view of the principles of treatment as reason and experience may supply.

4. A short general view will afterwards be given of the phenomena of disease, (semeiology,) the division and classification of disease, (nosology,) their distinction, (diagnosis,) their result, (prognosis,) and their prevention, (prophylaxis and hygienics.)

DEFINITION OF DISEASE.

5. The reader is supposed to be acquainted with anatomy and physiology: without a knowledge of these, we cannot proceed even to a definition of disease. Disease is known only by comparing it with the standard of health, which it is the object of anatomy and physiology to describe.

6. *Health* consists in a natural and proper condition and proportion in the functions and structures of the several parts of which the body is composed. From physiology we learn that these functions and structures have to each other and to external agents certain relations, which are most conducive to their well-being and permanency; these constitute the condition of health. But the same knowledge also implies that function and structure may be in states not conducive to their permanency and well-being; states which disturb the due balance between the several properties or parts of the animal frame; and these states are those of *disease*. For example, physiology, as well as experience, teaches us, that in health the digestion of food is easy and without annoyance. But when, after food is taken, there is pain, sickness, eructation, flatulence, or the like, we know that the *function* of digestion is changed from the healthy standard—is *diseased;* and if this diseased function continues long in spite of remedies which usually correct it, and if on examining the abdomen we find at or near the epigastrium a hard tumour, which anatomy teaches us is not there in health, we know that there is also *diseased structure.*

7. We find, then, (§ 6,) that there is *disease of function*, known by its deviation from a standard furnished by *physiology;* and *disease of structure*, which we recognize by a standard supplied by *anatomy*, (§ 5.) These varieties of disease may be, and very commonly are, combined: there is seldom structural disease without some disorder of function; and in many instances functional disease is, or will be, accompanied by a change of structure.

8. Looking, then, to anatomy and physiology as standards, we may define *disease* to be, *a changed condition or proportion of function or structure, in one or more parts of the body.*

9. The standard of health is not, however, the same in all individuals: that which is health to one may be disease to another. Thus if we instance individual functions. The healthy pulse in adults averages from 70 to 80; yet there are some in whom 90 or 100 is a healthy pulse. Some persons fatten on a quantity of food on which others would starve. The animal functions, muscular strength and activity, nervous sensibility,

and the sensorial powers, vary still more in different individuals, yet all within the limits of health: but what is health in one would be decidedly morbid in another. Such unusual proportions of certain structures or functions constitute varieties of temperament; and although they can scarcely be called morbid, yet they certainly give, as we shall afterwards see, a proclivity to disease.

CHAPTER I.

ETIOLOGY.—ON THE CAUSES OF DISEASE.

SECTION I.

NATURE AND DIVISION OF CAUSES.

10. DISEASE sometimes originates within the body from a change in some of the component parts of the animal frame, without any obvious external influence: thus disorder may arise from an undue proportion or predominance of a function, as that of the nervous system; or of a constituent of the body, as in the case of sanguineous plethora. Such states, however, constitute more commonly proclivity to disease than disease itself; and generally disease arises from causes extraneous to the body, although in many instances we may fail to detect these causes.

11. A great variety of agents and circumstances may act on the body so as to produce disease; but in most instances there is not that uniform and constant relation between these as causes, and the diseases as effects, which we might expect from the analogy of causation in the simpler sciences. In chemistry or in mechanics effects certainly and uniformly follow causes; in physiology or pathology, no doubt, effects also ensue; but whether these effects shall be manifest as disease or not, will depend on many circumstances, of which we often cannot take cognizance. It is true that when the causes resemble and act like those of physics or chemistry, their proper effects will not fail to ensue. Thus, a cutting instrument, a red-hot iron, or a corrosive liquid, will not fail to produce disease, because it overcomes vital properties by physical and chemical, and disorder must follow. Further, certain poisons and other energetic agents, which act on without destroying the vital properties of living parts, may also, if of sufficient strength, pretty constantly produce

morbid effects. Thus, opium causes somnolency; tartar emetic excites nausea and vomiting, &c.

12. But the common causes of disease are seldom of this decided and positive character; they are often present without disease ensuing; and they are known to be causes only because disease is observed to ensue in a greater number of cases when they are present than when they are absent. Thus, improper food is a cause of indigestion, and exposure to cold is a cause of catarrh; yet many persons eat unwholesome food without suffering from indigestion, and many are exposed to cold without "taking cold." But those who *do* suffer from indigestion observe that they do so more after taking improper food; and those who *are* affected with catarrh can often trace it to exposure to cold. The reason of this uncertainty of action is chiefly in various powers by which the body resists the morbific influence; which powers vary much under different circumstances. The failure of this power constitutes a predisposition to disease.

13. Causes of disease were formerly divided into *remote* and *proximate:* the remote include both the *predisposing* and the *exciting* causes, the only circumstances now considered as causes. They were called *remote*, not because they are distant or not in the body, but because they are not, like the proximate cause, a constant and present part of the disease. The term *proximate* cause was used by Cullen (after Gaubius) to represent the pathological condition, or essential bodily change, on which the symptoms depended; and it was called a *cause* of *the disease*, because diseases were by him defined to be an assemblage of symptoms. But this essential bodily change is rather a part of the disease than a cause, and must be considered under the head of *pathology*. Discarding, then, the term proximate cause, we have only to consider the *predisponent* and *exciting* causes.

14. The co-operation of both these kinds of causes is generally necessary to produce disease. A number of persons are exposed to cold: one gets a sore throat; another, a pleurisy; another, a diarrhœa; and a fourth escapes without any disease. All four were exposed to the same cause, yet it acted differently on all. The three first were *predisposed* to the disease, which attacked them as soon as it was *excited* by the cold. The fourth had no predisposition; the *exciting* cause was therefore powerless; it was insufficient without the predisposing cause; as in the other cases, the predisposition was insufficient until the exciting cause, the cold, was applied.

15. In some cases, however, where sufficiently strong, what is in a smaller degree a predisposition, in a greater degree constitutes a sole cause of disease, (§ 11:) thus a person with a very weak

stomach always has indigestion, whether an exciting cause be applied or not. So likewise exciting causes, if sufficiently strong, may produce disease without predisposition: thus a person not predisposed to indigestion may be pretty sure to earn it, if he take a sufficient quantity of raw cucumber, pickled salmon, or any such indigestible matter. Take another example. A healthy person living in a marshy district may not get an ague, until he becomes debilitated by any cause, such as cold, or fatigue: then the poison will act. But without his being thus weakened, if the exciting cause be made stronger by his sleeping on the very marshy ground itself, then the poison may act without predisposition, and the ague begins, (§ 12.)

16. The consideration of these facts throws some light on the nature of many predisponent causes. There is in organized beings a certain conservative power which opposes the operation of noxious agents, and labours to expel them when they are introduced. The existence of this power has long been recognized, and in former days it was impersonated. It was the *archæus* of Van Helmont; the *anima* of Stahl; the *vis medicatrix naturæ* of Cullen. But without supposing it to be aught distinct from the ordinary attributes of living matter, we see its frequent operation in the common performance of excretion; in the careful manner in which the noxious products of the body, and offending substances in food, are ejected from the system; in the flow of tears to wash a grain of dust from the eye; in the act of sneezing and coughing to discharge irritating matters from the air passages; and in the slower, more complicated, but not less obvious example of inflammation, effusion of lymph, and suppuration, by which a thorn or other extraneous object is removed from the flesh.

17. This *vis conservatrix* (§ 16) is alive to the exciting causes of disease; and in persons in full health it is generally competent to resist them. How it resists them will depend on what they are. For instance:—Is cold the cause? It throws the blood inwardly; this, by increasing the secretions, and exciting the heart to reaction, establishes a calorific process, which removes the cold. Is the cause improper food? The preserving power operates by discharging this speedily by vomiting, or by stool. Is it a malarious or contagious poison? It carries it off in an increase of some of the secretions. But if this resisting power (§ 16) be weakened, locally or generally, or if the exciting cause be too strong for it, then the cause acts, and disease begins, (§ 15.)

18. In the cases hitherto noticed, predisponent causes consist in absence or deficiency of power (§ 16), rather than the existence of any thing positive: but sometimes predispositions depend

on something positively wrong in the organization; and this error may be congenital, or hereditary, or acquired from previous disease.

19. It must be observed that predisponent causes operate chiefly through the constitution, or some of its powers; hence they are often called *constitutional* or *internal* causes, in contradistinction to the exciting causes, which are more commonly *external*. But these terms are objectionable, because not always applicable. Sometimes the term *predisposing* is also inappropriate, as in the following instance. Several persons are exposed to a malarious or infectious poison: some of these afterwards suffer much from fatigue or privation; they then begin to show the effects of the poison: others, who have not suffered this second trial, escape unhurt. The poison has entered the system of both; the last resist its influence; the subsequent weakening reduces the powers of resistance in the first class, and exposes the system to the exciting cause; but occurring after, it cannot be said to *predispose*. Hence, under such circumstance, the fatigue or privation is called the *determining* cause.

SECTION II.

PREDISPOSING CAUSES OF DISEASE.

20. It will be useful to illustrate, by a few examples and explanations, the chief predisposing causes of disease. In doing this, I shall enlarge on a list supplied in Dr. Alison's "Outlines of Pathology."

I. Debilitating Causes of Predisposition are the most numerous of any. So we might expect from the fact that constitutional strength generally implies power of resisting disease, (§ 16, 17.) The weakness which renders the body liable to disease is that especially which enfeebles the heart, and impairs the tone of the arteries: it is often accompanied with an unusual susceptibility of the nervous system, which increases the liability of the body to suffer. The following are the chief of this class.

21. (1.) *Imperfect nourishment*, whether from defect in the quantity or quality of the food, or from incapacity of the digestive powers. This in itself may cause many diseases, particularly of the digestive organs; but it also produces a liability to low fevers and inflammations, epidemic and contagious disorders. Thus the susceptibility of the body to infection when fasting, is generally acknowledged; and the rapid propagation of infectious diseases among an ill-fed population, such as the poor Irish, is too well known.

22. (2.) *Confinement in impure air.* The injurious effects of this are apparent in the pallid, cachectic complexion of the inhabitants of crowded cities, even those who live well and regularly. How do they contrast with the ruddy countenances of the hardy and coarsely-fed mountaineer! So do they also in their liability to diseases, particularly to those of the nervous and nutritive functions.

23. (3.) *Excessive exertion of mind or body without sufficient sleep.* Exercise is beneficial to both body and mind; but when it exceeds what the strength can bear, or rest can recruit, the animal functions are exhausted, and lose their balance, tone is impaired, nervous excitability takes the place of strength, congestions ensue, and various organs are on the brink of disease. It is thus that the fatigued mind or body is peculiarly prone to suffer from causes of disease.

24. (4.) *Long continued heat, particularly when combined with moisture, and unrelieved by the invigorating influence of occasional cold.* The debilitating effects of this agent are remarkably exemplified in warm climates and seasons. The muscles, and with them the heart and arteries, lose power and tone; vessels become relaxed; perspiration is profuse; and internal organs, especially the liver, are too much stimulated by blood that has lost more than usual of its water, and less of its oxygen. Hence the disposition to bilious and liver complaints, dysentery, and cholera. Overheated rooms and excessive clothing likewise predispose to disease by their weakening and relaxing influence.

25. (5.) *Long continued cold, not sufficiently counteracted by artificial protection and by muscular exertion.* Cold applied occasionally, invigorates, because it is followed by a healthy reaction, in which the vital properties are exercised and exalted. But when long continued, its sedative and debilitating effects are permanent; it weakens the circulation, especially that of the surface, causes internal congestions, and directly lowers all the vital energies. Hence the most malignant forms of epidemic fever in this country are observed to prevail towards the close of very severe winters; and all diseases may then assume a typhoid type. This is observed chiefly among the lower orders, whose means do not enable them to protect themselves sufficiently against the inclemencies of the season. We have before adverted to the striking manner in which cold disposes the body to suffer from malaria.

26. (6.) *Habitual intemperance with intoxicating liquors.* There is probably, in this country, no source of disease more fertile than this. Beside many which it excites, it also predisposes the body to attacks of fever, erysipelas, dysentery, cholera, dropsy,

rheumatic and urinary diseases; and if it do not increase the proneness to inflammatory disorders, the habit of intemperance certainly disposes them to unfavourable terminations, and causes many a victim to sink after accidents and operations, which would be comparatively trifling in a sober subject. Nor can we wonder at the pernicious effects of this kind of excess, when we consider the unsound state of function and structure which stimulating drinks induce, especially in the organs which they most directly affect, the stomach, the liver, and the kidneys. We shall soon have to explain how such an unsound state of these organs peculiarly impairs the powers of the body to resist or throw off disease, (§ 17.)

27. (7.) *Depressing passions of the mind, such as fear, grief and despondency.* Many are the instances in which numbers as well as individuals have escaped a prevalent disease, until depressed by some unhappy event or apprehension, and then they have fallen victims. Such was instanced in the ill-fated Walcheren expedition, and in many passages in the history of armies in pestilential countries. A defeat, a failure, or even bad news, made many succumb to the pestilence who had before escaped. It is a common remark, that when a contagious or epidemic disease prevails, those who take most precautions frequently suffer, because they are timid and fearful, whilst the stout-hearted and reckless are unscathed.

28. (8.) *Excessive and repeated evacuations, either of the blood or of some secretion from it.* The weakening effect of a large loss of blood needs no explanation; but the injurious influence of habitual losses, if they be more than the system can repair, is still greater; for the functions then become depraved, a state of cachexia as well as anæmia is induced, and a little cause may suffice to determine many states of disease. Various hæmorrhages and discharges, menorrhagia, diarrhœa, and other fluxes, if in excess, reduce the powers of life, and the capacity to resist disease. No secretion, however, weakens so much or so irreparably, when in excess, as that of semen. In many of the lower tribes of animals, the males live till they copulate, and then die: the reproduction of the species is at the expense of the individual. That our species is not wholly exempt from this law of organized nature, is apparent from the fact that immoderate venery is known to induce extreme debility and premature decay, and to dispose the body and mind to various diseases.

29. (9.) *Previous debilitating diseases, and the treatment used to remove them.* It is well known that the body is unusually liable to disorder during convalescence from serious maladies. It is weak in all its parts; and improper food, exertion, excitement, or exposure to cold, may readily produce the former or

some new complaint. Hence convalescence from a severe disease is a condition of health that requires peculiar care. The functions are but just resuming their balance, and have neither the capacity to act nor the power of resistance which is the attribute of robust health.

30. II. Hitherto we have considered only those circumstances which predispose to disease by their weakening influence, (§ 16, 17, 20.) There are others of a somewhat opposite character, which favour the production of disease by VASCULAR FULNESS OR ACTIVITY. Thus full living with insufficient exercise, and other causes of plethora, predispose the body to apoplexy, hæmorrhages, and gout; and although it is doubtful that they increase the tendency to inflammation, yet they make it more intense when it does occur. So, also, undue fulness of blood-vessels in a part, when insufficient to produce disease, renders the part more liable to suffer from external causes. Thus the periodic determination of blood to the uterus and mammæ renders them liable to disease at that time. Violent exertion makes the muscles or their fasciæ peculiarly liable to rheumatic inflammation on exposure to cold. Excessive indulgence in a stimulant diuretic beverage, such as punch, renders the kidneys liable to disorder on exposure to cold. Inflammation or irritation of the intestines is not a common effect of cold, except when these viscera are under the exciting influence of a purgative.

31. III. Proclivity to disease is not unfrequently caused by PREVIOUS DISEASE, independently of the weakening influence before noticed, (§ 29.) This is particularly the case with some inflammatory and nervous disorders. Thus, a child who has once had croup is very liable to its recurrence. One attack of enteritis frequently predisposes to its recurrence. Convulsive disorders, such as chorea, hysteria, and epilepsy, are extremely apt to recur; and the longer they have existed, the more difficult are they to remove, and the more ready are they to reappear on the application of any exciting cause. This is what may be called a habit of disease, which it is most important to prevent. There can be little doubt that the previous attack in all such cases leaves some change of structure or function, (§ 18,) which constitutes the predisposition, although this change may elude our means of detection.

32. Under this head we may arrange many constitutional predispositions to disease which are to be ascribed, not to a previous attack, but to the persistence in the system of a cause of that attack. Rheumatism, gout, gravel, many cutaneous diseases, dropsy, jaundice, and many others, may be quoted as

examples. A person who has once suffered from any of these is very liable to a recurrence on the application of an exciting cause; and this is, because, although free from the first attack, he may not be free from some functional or structural imperfection (§ 18) which was the predisponent to that attack, and which may again be brought into operation by the addition of an exciting cause. In most of these cases the constitutional defect is in some of the processes of assimilation or excretion, this defect being generally functional, but in some cases it is also attended with change of structure, especially in the great eliminating organs, the liver and the kidneys. When the tendency to the diseases under notice is acquired, it may be often traced to causes which peculiarly affect these organs, such as intemperance or irregularities of diet, and scarlet fever.

33. Nor can we separate from this class of constitutional causes (§ 31) the predispositions to many structural diseases, such as tuberculous and malignant formations. Where such have once appeared, there is a tendency to the production of more, although this tendency may be latent until brought into activity by an exciting cause. In the following pages many arguments will be found in favour of the view that the disposition to these diseases is connected with errors in the functions of assimilation and excretion, (§ 32.)

34. IV. Organic disease already existing in the body, even when itself latent, often predisposes to other disorders, independently of its weakening effect, (§ 20.) Thus tubercles and other tumours, structural lesions of the heart and other organs, often induce irritations or obstructions of blood-vessels, which, if not themselves causing open disease, render them ripe for mischief inflicted by other causes. Thus a person on the occasion of violent bodily or vocal exertion is seized with profuse spitting of blood, which causes his death: on opening the body many tubercles are found in the lungs, although there had been no obvious symptoms of their existence before the violent effort. Again, disease of the heart causing accumulation in the veins often leads to congestion of the lungs and liver; and it may only require the addition of an exciting cause, such as sudden exertion or an excess in diet, to bring about an attack of asthma or jaundice.

35. The predisposing causes hitherto considered may be called accidental or acquired. There are others which are born with the individual; and others which arise from circumstances of age or growth. All these may be supposed to depend on something defective or ill-balanced in the organization, (§ 18,) which is insufficient to manifest itself until wrought upon by an external exciting cause.

36. V. Of the predispositions born with the individual, the most generally acknowledged is HEREDITARY TENDENCY TO DISEASE. It is well known that scrofula, gout, leprosy, epilepsy, mania, asthma, blindness, and deafness, run in families. That this depends on individual peculiarities transmitted from parents to offspring, appears from the fact that all children do not partake, or not alike, of the disposition. Nay, sometimes a whole generation is passed over, and the disease appears in a third. So too we see external organization, family likeness, differently stamped on different children of the same family.

It must not be supposed that hereditary proclivity to disease commences at birth. In a few instances it is congenital; but in the greater number it is developed by growth or some other circumstances in life. Gout, for example, is acknowledged to be hereditary. A parent has it in middle or advanced life: his son does not get it until about the same period, sooner or later, according to whether he lives freely or not. Here is something transmitted from father to son, yet not manifested in the son for forty or fifty years.

37. VI. Frequently but not essentially connected with hereditary conformation is the peculiarity of constitution called TEMPERAMENT, which certainly predisposes to particular diseases. Temperament is constituted by a predominance or defect of some function, (9.)

38. Thus the *sanguine* temperament implies an activity of the system which circulates red blood, and a rich proportion of red particles, manifest in the excitable pulse and flushing cheek of those of this temperament; and further evinced in their quick movements and lively disposition. This temperament gives a disposition to inflammation, determination of blood, and active hæmorrhage, (30.)

39. In the *bilious* or *melancholic* temperament, which is commonly met with in persons of dark complexion and gloomy disposition, there is probably a defective action in some of the biliary or digestive organs, which are therefore the more liable to derangement, (9.)

40. In the *phlegmatic* or *lymphatic* temperament, which generally occurs in those with weak pulse and languid circulation, cold extremities, and pallid skin,—there is a deficiency of red blood and of vascular action and tone, (§ 9,) and the proclivity is to watery fluxes, dropsy, and other chronic affections.

41. The *nervous* temperament is externally manifest only by agitation or hurry of manner: it seems to depend on an excess or want of proportion of some properties of the nervous system, (§ 9,) and it predisposes to the disorders called nervous, such as

hysteria, nervous pains, spasms, &c. These temperaments may be variously combined.

The term *diathesis* is often used to express a particular morbid tendency; thus we hear of the inflammatory diathesis, the scrofulous diathesis, &c. It is merely a name, signifying predisposition, without affording any clue to its true cause.

42. VII. The last head of predisponent causes to be noticed is AGE. The several changes in organization as well as in external circumstance which the animal frame undergoes at different periods of life, may naturally be expected to be attended with corresponding proclivities to disease. I proceed to enumerate a few of these, premising that some of the examples may be entitled to rank under the head of exciting causes of disease, as well as under that of predispositions.

43. (1.) *In early infancy*, the low calorific power of the body disposes it to suffer from the bad effects of cold, (§ 17,) whence the tendency to visceral inflammations. The skin is particularly liable to various eruptions in consequence of its tenderness and the new and drying medium in which it is placed. The redness of new-born children is obviously the result of the action of the air; it is often a vivid erythema, followed by desquamation of the cuticle, and a yellow stain of the skin from extravasated hæmatosin, which is erroneously thought to be a kind of jaundice. Strophulus and other papular eruptions often succeed. The comparatively virgin state of the alimentary canal at birth renders it peculiarly susceptible of disorder; and a similar trial may occur at the period of weaning; hence arise diarrhœa, vomiting, colic, waterbrash, atrophy, and other ailments connected with disordered digestion.

The brain, excited by the novelties of the external world, becomes rapidly developed, and in its increased activity and growth is liable to various diseases, (§ 30,) hence the proclivity to hydrocephalus, convulsions, &c.

The process of teething adds an irritation, which, by its influence on the head, the bowels, and the air passages, disposes them to disorder.

44. (2.) *Childhood, or the age from infancy to puberty.* The functions most active are those which administer to growth: the organs of digestion and assimilation are therefore obnoxious to disorder, (§ 30;) hence derangements of the stomach and bowels, worms, infantile remittent, &c.

The activity of the nutritive function gives a preponderance to the fibrinous or proteine constituent of the blood; and inflammations which may occur are often attended with the effusion of much plastic or albuminous matter; hence the products of croup, tubercle, mesenteric disease, &c.

The natural mobility (or activity of the excitomotory system) of childhood predisposes to chorea and kindred affections, (§ 30.)

45. (3.) *Puberty* brings with it many morbid susceptibilities, chiefly in the female sex, in which the important function of menstruation is to be established. Many and serious are the evils that are liable to be produced by external causes, which check the development of this function. So also when established, this function has its nervous as well as its vascular relations; and where it is irregular or disordered, a predisposition is given to many maladies, affecting the blood-vessels and their contents, the secreting organs, and the nervous system.

46. (4.) *At the termination of growth*, there is another critical period. The cessation of that appropriation of nourishment for the increase of the body, that had hitherto been going on, may cause fulness, and a disposition to hæmorrhage and inflammation in the more robust; and in the cachectic, to morbid depositions, especially of the tuberculous kind, (§ 47.)

47. (5.) *Adult age* can hardly be said to predispose to any diseases, unless it be those arising out of occupation, and those connected with the generative function, for which this age is obviously the natural period. When this function fails, at what is termed the change of life, there is a remarkable tendency to various diseases, generally connected either with vascular plethora, or with morbid growths of various kinds, particularly in the uterus, ovaries, mammæ, testes, prostate, rectum, &c.

48. (6.) As *old age* approaches, habits are more established; and unless they are such as are calculated to maintain the balance of the functions, (§ 6,) they gradually affect the organization, and accelerate those changes in the fabric, by which our existence is limited to a span of years. It would occupy too much space to enter into the details of all these changes, but some of the principal may be briefly noticed.

The nutritive function becomes impaired; and instead of muscles, fat, and integuments being nourished in the equal proportions that give beauty as well as strength to the form in early adult age, the deposition of fat becomes scanty, partial, or in excess; the muscles become thinner and more sinewy; and the integuments are loose and wrinkled, or fat and flabby. The blood-vessels, too, lose their proportion and mutual adaptation. The arteries become less elastic, and transmit the heart's pulse unsoftened to the capillaries. The veins become distended and tortuous; particularly in persons whose employment has required much muscular exertion. The capillaries have no longer the vital susceptibility which is evinced in the blush of youth. This altered proportion of the blood-vessels brings with it morbid tendencies, the nature of which will depend much on the great moving power, the heart; now more than ever the prime agent in the circulation. If the heart be moderately strong, a fair balance may long be sustained; although hæmorrhoids, varicose veins, and such irregularities from local obstructions, may occur. If the heart be too strong, (which is often the case after a life of much muscular exertion,) the small arteries may suffer from the unsoftened force of its pulses, particularly in the brain, and there is a liability to apoplexy or palsy: and in mucous membranes there is a disposition to active fluxes and hæmorrhages; hence catarrh, asthma, and affections of the urinary organs. If the heart be weak or diseased, there will be imperfect circulation and tendency to venous congestions, dropsical effusions, imperfect and disordered secretions, and a general failure of all the functions, which depend on a sufficient supply of arterial blood: hence may arise diseases of the liver, stomach, kidneys, lungs, and in fact any of the viscera: in extreme cases the lower extremities actually die for want of circulation.

If instead of the organs of circulation we were to take the alimentary, the respiratory, or the urinary apparatus, we should here too find changes induced by age, which show the necessarily limited time that man's organization is intended to last. Old age is thus attended with increasing infirmities and liabilities to disease, (§ 16, 18.) The very strength and activity which some functions retain, may, from their partiality, endanger life; and their gradual and more equal failure degrades the physical and often the mental frame of man to a lower scale of existence, until he sinks into second childhood, dotage, and imbecility.

SECTION III.

EXCITING CAUSES OF DISEASE.

49. WE now pass to the consideration of *exciting* or *occasional causes* of disease, or those circumstances and agents which, operating on the body, especially when predisposed, (§ 14,) may excite disease in it. It has been stated before, (§ 11, 15,) that certain powerful agents, such as irritants or poisons, pretty surely cause disease, independently of constitution or predisposition; but constitution or predisposition may much modify the character of this disease in different cases; and where the agents are less powerful, as in the case of common causes of disease, the effects will depend still more on the predisposition, and may be null where this is not strong, (§ 15, 19.)

50. Exciting causes may be divided into the COGNIZABLE and NONCOGNIZABLE. The former class comprehend physical and mental agents, of whose existence we can take cognizance, independently of their operation in producing disease; thus cold we know by its effect on our instruments and sensations; muscular exertion by our witnessing or performing it; and mental emotion by our consciousness of it. The *noncognizable* causes, on the other hand, elude our senses, and we infer their existence only from their morbific effects: thus malaria and infection we know by no other property but that in question. The subjoined table includes both classes.

Exciting Causes of Disease.
- I. Cognizable Agents.
  - 1. Mechanical.
  - 2. Chemical.
  - 3. Ingesta.
  - 4. Bodily exertion.
  - 5. Mental emotion.
  - 6. Suppressed or defective evacuation.
  - 7. Excessive evacuation.
  - 8. Temperature and changes.
- II. Noncognizable Agents.
  - 1. Endemic, 2. Epidemic, 3. Infectious — Poisons.

I. COGNIZABLE AGENTS.

51. (1.) *Mechanical causes, which injure structure, or impede or derange function.* Besides the obvious instances of tearing, cutting, pinching, striking, and straining, which produce at once diseases which fall under the province of the surgeon, the physician finds many mechanical causes of diseases which he has to treat. Long-continued pressure of articles of clothing may produce disease. Tight neckcloths may produce apoplexy, by impeding the flow of blood from the head. Tight stays may cause fainting, by pressure on the heart and great vessels; or colic and costiveness, by obstructing the free passage through the great intestines. Pressure on the epigastrium by sitting at a desk after a meal, may cause indigestion. Long continuance in one position, whether standing, sitting, or lying, will partially obstruct circulation and innervation, and produce swelling and paralysis of the lower parts, or those beyond the seat of pressure, and in time may cause inflammation and death of the parts pressed upon. Mechanical causes also operate within the body. A stone in the bladder irritates by its mechanical properties, especially if it be of the mulberry kind; or it mechanically stops the flow of urine: so also may a gall-stone that of the bile. The intestinal canal is often mechanically stopped by hardened fæces, and irritation and inflammation may ensue. The stomach is

often irritated by the mechanical qualities, bulk, hardness or asperities of its contents: thence may ensue vomiting, indigestion, or inflammation of the organ. The air-passages of needle-pointers, stone-masons, &c., are irritated and inflamed, and at length altered in structure, in consequence of the mechanical action of particles of stone or other substances, which these men are continually inhaling in the course of their employment.

Instances are endless; and the further effects of disease are also in great measure mechanical. For example: the influence of tumours, of diseases of the heart and vessels, the lungs and air-passages, intestines, and urinary apparatus, injuries and diseases of the bones and ligaments, &c. &c., is in great part mechanical, interfering with the natural mechanism.

52. Besides their simple mechanical effects on structures and functions, (§ 51,) some mechanical injuries, when extensive, directly depress the vital powers; thus crushing or tearing off a limb, or a blow on the epigastrium, causes fainting and extreme weakness of the heart's action, and may thus cause death. Slighter mechanical injuries are causes of irritation or excitement, which may be local or general, according to circumstances.

53. (2.) *Chemical causes* of disease are even more varied than mechanical, because chemical agents are more numerous. We are acquainted less with the chemistry than with the mechanism of the animal body, and therefore can less distinguish causes which act by chemical properties from those which have complex relations to vital properties. But we recognize chemical irritants in acids and alkalies and many salts, whether applied liquid, or inhaled in form of gas or vapour. So what are called chemical poisons, such as corrosive sublimate and other metallic salts, the strong acids and alkalies, iodine, chlorine, &c., produce disease by their known powerful chemical affinities, which tend to decompose tissues and disorder functions.

We cannot doubt that many of the matters which cause disease in the alimentary canal, do so by virtue of their chemical qualities. The process of digestion, although always in part chemical, is so under the superintendent influence of a superior vital power: no sooner does this power fail, or the chemical agencies or decompositions become too strong for it, than we have fermentation and putrefaction, which cause eructation of gas or sour liquid from the mouth, and there may follow the discharge of ill-coloured and unusally fœtid matter by stool: then, too, may arise a number of disorders, which may in great part be referred to the influence of these injurious chemical processes.

There can be little doubt, too, that the chemical composition of the different constituents of the body is subject to variations which may themselves become causes of disease. The altered state of the blood which we see in malignant cholera, scurvy, typhous and inflammatory fevers, is a proof that there is a great difference in this fluid; but how far this is a simply chemical, or a vital and chemical change, is as uncertain as is the question of the vital properties of the blood in health.

54. (3.) *The solid and liquid ingesta* are a fertile source of disease, and in various ways. Their mechanical and chemical properties have been already noticed, (51, 53.) But further, the ingesta may cause disease—

α By non-alimentary matters acting injuriously.

β By aliment defective, or ill proportioned in quantity.

γ By aliment defective, or excessive in quantity.

55. (α) Of the non-alimentary matters contained in the ingesta, salt, spices, pickles, and other condiments, and spirituous or fermented liquors, are frequent exciting causes of disease. They are all more or less irritating or stimulating to the digestive apparatus; and if used indiscreetly may induce inflammations, congestions, and functional disorders of these organs, and, in some instances, irritation of other parts, and of the whole system. Salt in excess irritates the stomach, causes feverishness with thirst, and, according to Liebig, impedes the deposition of fat. Animals will not fatten on salt food;—a hint for the corpulent.

56. But the operation of intoxicating liquors is more extended: being soon absorbed, their stimulant action is directly felt on distant parts, especially on the vascular and nervous system. Being absorbed by the veins, they pass by the portal vein into the liver, the function and structure of which is particularly apt to suffer when spirits have been freely indulged in. So too the kidneys, which are the natural emunctories through which such extraneous matters are eliminated from the system, are often over-stimulated, and are injured in their secreting power, and ultimately in structure also. The heart and vessels are over-excited at the time, and afterwards lose their tone; and the processes of secretion and nutrition become variously disordered. The nervous system is an especial subject of the disordering influence of intoxicating liquors. A large quantity taken at a time is a narcotic poison, inducing, first, cerebral excitement, then intoxication, and insensibility. The functions of the brain are more or less impaired, and at last those of the spinal marrow; and if the influence be insufficient to stop respiration, yet it may be imperfectly performed, and congestions are formed in the brain and other organs. Hence, apoplexy, palsy, phrenitis, delirium tremens, may follow, and the whole frame may suffer from the effects of the poison. Even when less excessive quantities are taken, and their first effect is mere intoxication, the headache, sickness, and inappetency, and the feelings of wretchedness and depression which often ensue, sufficiently

prove that disorder has been produced, and that such artificial excitements cannot be abused with impunity.

Yet these and other adjuncts to food, when taken with moderation and discrimination, often prove useful, to aid the digestion where it is weak, and to counteract various exhausting and depressing influences, which are frequently arising out of the artificial condition and employments of society, especially in large towns. Total abstinence, therefore, is preferable to moderation, only because it is morally easier to practise, not because it is more salutary in its physical effects.

57. Disease may be excited by unwholesome articles with which the food is adulterated. To this class of causes belong various poisons; the operation of some of these will be noticed under the head of causes of death: but for further details, works on toxicology and materia medica must be consulted. There are some noxious matters occasionally mixed with food, which gradually produce deleterious effects. Thus salted provisions too long used will cause scurvy; ergotted corn has been known to produce dry gangrene. Lead gradually introduced causes constipation, colic, paralysis, and atrophy. I fear, too, that under this head we must confess that medicines are fertile sources of disease, and that, not only when *injudiciously* administered; the remedies *necessary* to cure or relieve many diseases are not uncommonly *necessary evils;* they remove one disorder by inducing another, and are entitled to rank among the causes of disease.

58. (β) Aliment ill proportioned in quantity is another article of the ingesta that may cause disease. Man is by nature and habit an omnivorous animal; and in general his health is best maintained by mixed proportions of animal and vegetable food. The insalubrity of the simpler constituents of food, when separate, even those supposed to be most nutritive, has been well shown by the numerous experiments of Majendie, Gmelin, and others. They fed dogs, geese, donkeys, and other animals, on articles which are generally considered highly nutritive, as sugar, gum, oil, or butter: the animals died with symptoms of starvation almost as soon as if they had been kept without food. Even bread, when too fine, is insufficient for nutriment. A dog fed on pure white bread lived only fifty days, whereas another fed with the coarsest brown bread was well nourished, and seemed capable of living an indefinite period. According to the researches of a commission of the French Institute, (the report of which was published in 1841,) gluten, or vegetable albumen, is the only simple principle which will alone maintain life, and the nutritious qualities of vegetable food depend chiefly on the quantity of this azotized principle which they contain. Bread may therefore well be called the *staff of life.*

Animal albumen and fibrin require mixture with vegetable matter to make them properly nutritious as well as wholesome; and gelatine and oily matters are still less available for nourishment without much combination.

59. Liebig has recently advanced some novel views with regard to the purpose of the different proximate elements of food. He considers that the albuminous principle alone nourishes the body; all other proximate elements go to supply the excretions; their carbon and hydrogen being united with the oxygen absorbed in respiration, and thrown off in the form of carbonic acid and water; and the nitrogen with the remainder of hydrogen and carbon being separated in the constituents of bile and urine. The union of the combustible constituents of the food with the oxygen inhaled, he considers to be the great source of animal heat, which is raised by oily or saccharine matters in the food, together with the increased supply of oxygen afforded by cold air or exercise. Thus the Laplander eats train oil for fuel; whilst the Italian, under a sunny sky, delights in maccaroni, which nourishes without heating him. If the inhabitant of a warm climate indulges in rich, greasy food, he loads his blood with hydrocarbon, which the scanty oxygen of the rarer air which he breathes is insufficient to remove; the liver is overtasked to eliminate the superfluous matter, and is therefore liable to derangement. These and other views of this distinguished chemist are highly interesting, but as yet they seem too speculative to become the basis of pathological reasoning.

60. The views of Dr. Prout* on the due proportion of alimentary matters, although also in some measure hypothetical, are more in accordance with common experience. He considers milk to be the great prototype of all food: as its nutritious part consists of albumen, oil, and sugar, so all our wholesome meals, or artificial combinations of food, comprise these three ingredients; albumen being isomeric with fibrin and gluten, (that is, identical in ultimate composition,) and starch with sugar.

61. Every day's experience may teach us that disorder is apt to occur if we do not duly proportion the articles of food: thus if we take too much butter or fat, we become sick and bilious; if we subsist too much on farinaceous food, we become costive, for want of bile; if we eat meat too freely, we become bloated and heated, the urine becomes high coloured, and if we persist, we may become the subjects of plethora, inflammation, gout, or calculous disorders: if, on the other hand, we feed too exclusively on vegetable food, we lose colour and muscular strength. The appetite and taste generally instruct us pretty safely as to the best

* "On Stomach and Urinary Diseases." 1840. P. xvi.

proportions of different kinds of food; but then they must not be perverted and pampered by condiments and recherché modes of cooking. These are expedients to coax and deceive the appetite and taste; and if these guardians of the nutritive department are cheated, it is no wonder that the department becomes deranged.

62. (γ) Aliment may be *excessive* or *deficient* in *quantity*. Sometimes the appetite is inordinate; more frequently it is pampered; in either case, *more food* is taken than the expenditure of the system requires. If the digestive organs fail in appropriating the nourishment, they become distended, irritated, and otherwise disordered by what they cannot digest. If they are strong and digest the excess, they send too much chyle into the blood, and this may cause plethora, apoplexy, gout, gravel, or some congestive or inflammatory disorder to which the individual is predisposed, (§ 14.)

63. *Defective* nourishment may excite various disorders. In the extreme case of privation of food the cravings of hunger are alternated with nausea and a sense of sinking; then follow fever, delirium, and general disorder of both body and mind, with increasing feebleness. It is a curious fact, that in this state the stomach becomes inflamed; probably from the irritating action of its secretion on its unrelieved vessels. Even in less degrees of abstinence, enjoined in the treatment of disease, symptoms of vascular and nervous irritation often arise in the midst of general weakness. By many practitioners of the Broussaian school, these symptoms are erroneously taken as indications for an increase of the antiphlogistic plan, when a judicious return to nourishing food will really prove the best cure. Deficiency of food, if long continued, causes general weakness of all the functions and wasting of all the textures. The blood becomes thin and easily extravasated; the gums spongy and bleeding; the legs œdematous; diarrhœa often occurs; ulcers appear in the cornea and other parts; a state of scurvy or cachexy is induced, from which, if advanced, an improved diet may now fail to restore. In less extreme cases, poor living may excite scrofulous and tuberculous disease, and other kindred forms of degeneration of organs. The bad influence of poor living is much more felt in those who are confined in close habitations, as in prisons, poor-houses, the cabins of ships, and besieged towns, than in those who are at large, (§ 22:) and it is under such circumstances that the insalubrity of some kinds of food, however nutritious, becomes apparent. Thus even bread with meat or broth will not exclude scurvy; but a sufficient addition of fresh vegetables, and even of potatoes, prevents this disease from occurring.—(Dr. Baly, Med. Gaz., Feb., 1843.)

64. (4.) *Violent bodily exertion* of various kinds is a common

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exciting cause of disease. General muscular efforts, as in running, walking up hill, rowing, &c., hurries the movement of the blood back to the heart, and resists its distribution through the arteries in such a degree that the heart, the lungs, the brain, and other organs, have an unusual pressure of blood upon them, (§ 51.)

The heart is excited to inordinate action, is often strained and distended, and its function, or even its structure, and that of the great vessels, may be impaired in consequence. This is especially apt to happen if there is any thing already imperfect in the structure of the organ, its valves or vessels; and there are naturally very various degrees of perfection and strength in these parts.

The brain is particularly liable to suffer from violent exertion, especially if joined with a stooping or constrained posture; for its vessels are not, like those of the limbs and trunk, supported by muscular pressure upon them, and the excited heart can therefore send its blood into them with more force. Hence giddiness, noise in the ears, deafness, defective vision, convulsions, palsy, and apoplexy, have been brought on by violent exertion.

The lungs are also apt to suffer; for the blood being returned to them faster than they can arterialize it, they become greatly congested; hence cough, dyspnœa, hæmoptysis, or inflammation of the lungs, may ensue; and the texture of the lungs may also sustain injury in consequence of the violent strain to which it is subjected by the increased exertions for breath.

Other internal organs sometimes are disordered by the blood thrown or retained in their vessels by the pressure of external muscular action. Derangement of the liver, hæmatemesis, hæmorrhoids, and hæmaturia, have been brought on by such a cause. The sharp pains or stitches felt in the sides or abdomen on running fast are commonly supposed to be in the liver or spleen; but more probably they are spasms of the intestines—temporary colic, produced by irregular pressure on them, when their sensibility is raised by the blood unduly thrown into them.

Some kinds of muscular exertion peculiarly affect certain organs. Thus loud reading or speaking, or blowing wind instruments, especially try the organs of respiration and the voice, and may cause hæmorrhage, inflammation, and various diseases of these organs. Excessive or rough riding or leaping may injuriously affect the kidneys and organs of generation. Straining to lift a heavy weight, or at stool, or in any continued effort, which implies holding the breath, endangers the structure of the vessels of the chest and brain, on which there is no equally counteracting muscular pressure.

65. Bodily exertion may also cause disease by its exhausting

effects. In extreme degrees this exhaustion may amount to syncope, and even death: short of this, it may cause great weakness of muscles and of the heart, with corresponding depression of other functions. A low typhoid or adynamic fever sometimes follows prolonged fatigue. In other cases, giddiness, nausea, loss of appetite, indigestion, costiveness, amenorrhœa, and other varieties of injured function.

66. (5.) *Strong mental emotion*, or *acute sensation*, is a common cause of disease. Closely knit together as the mind and body are—so closely, that their great common organ, the nervous system, seems to have double offices for both—it is not surprising that they should ever be ready to affect each other, and that when the impression is strong, the affection should not be slight or transient. The heart most remarkably suffers from such causes. Thus a sudden shock, whether of grief, surprise, fear, or even joy, may cause fainting, partial suspension of the action of the heart; nay, even death has ensued; and the expressions "frightened to death," and "killed with joy," are not always mere figures of speech. Sudden acute pain often causes fainting. Palpitation and irregular action of the heart are very common effects of emotions.

Other parts also suffer from strong moral impressions. Spasmodic asthma and spasmodic affections of the throat are sometimes thus induced. Apoplexy, palsy, inflammation of the brain, epilepsy, and insanity, have been caused by excessive anger, terror, surprise, and joy.

Very commonly, mental emotions affect the secreting organs, and especially the functions of the alimentary canal. A piece of very bad news takes away appetite, or impairs digestion. Fright or anxiety often loosens the bowels, or brings on a bilious attack, or jaundice. The uterine periodic function is remarkably subject to the influence of moral emotions, and many of its disorders may often be traced to this source.

The slower emotions of the mind and over-exertion of its faculties are also exciting causes of disease. Long-continued depression or anxiety sometimes induces dyspepsia, costiveness, or diarrhœa, asthma, and functional disorders of the heart, menorrhagia, and dysmenorrhœa; and in time structural diseases of the same parts occasionally follow these functional affections. Over-exertion of the faculties, or excitement of the passions of the mind, is chiefly felt in its own functions, or in its own organ the nervous system. Hence may arise congestions of the brain and exhaustion of nervous power, with giddiness, stupor, headache, dull and disordered sensation, and even apoplexy and palsy. Or the disease may be inflammatory, with symptoms of irregular excitement, nervousness, delirium, tremor, convulsion, partial paralysis, &c. Sometimes the effects of excessive mental exertion or moral emotion are apparent only in the phenomena of the mind, the powers of which are injured or disordered, and various forms of insanity are produced. When we consider the variety and amount of food and condiment, employment and excitement, that pass into the minds of persons in the busy and worrying scene of civilized life, it is not extraordinary that the mind, as well as the digestion, or other function, should occasionally be disordered by such causes.

67. (6.) Diseases are frequently excited by the *retention*, *diminution*, or *suppression*, of *evacuations*, *natural* or *habitual*, especially if the change be sudden. The operation of this class is somewhat diversified, causing disease, some by the positively noxious influence of matter retained in the system, which is the case of the excretions of urine and fæces; others, by causing fulness of the vessels, and the various disorders which this may induce. To the latter cases belong sudden suppression of hæmorrhages, or other discharges which have become habitual.

The matter of alvine and renal excretions is essentially pernicious, and cannot be long retained even in their natural repositories without causing mischief. Fæculent matter, when it has reached the large intestine, is still acted on by the absorbents, which take up its more fluid parts, and with them, if long retained, fœtid matter, which ought to be excreted. The solid residue becomes hard and scybalous, and may remain lodged in the cells of the colon, a cause of irritation, distension, and obstruction, (§ 51.) Sometimes the system suffers before the intestine itself; at length, however, or sometimes at first, this part becomes irritated, colic, diarrhœa, and inflammation, may ensue —nay, in some instances, where efficient remedies have been neglected, even ulceration and other structural changes take place, before the offending matter has been dislodged.

The retention of urine has even more pernicious effects. Besides mechanical distension, and irritation, and rupture, which may follow from the constantly accumulating secretion, (§ 51,) the fluid is partially reabsorbed, giving a urinous smell to the breath and perspiration, and sometimes causing typhoid symptoms, which in extreme cases prove fatal, with delirium or convulsions, and coma; and effusions of serum, containing urea, are found in the brain, chest, and other parts. These are effects more commonly of suppression than of mere retention; but, in fact, suppression often follows retention: the retained urine is prone to decomposition, (§ 53;) highly irritating and offensive matters are produced, which cause injury to the bladder, rapidly extending up the ureters to the kidneys, whose function then becomes impaired or suppressed.

68. The preceding are exreme results; but the attentive observer will find that smaller degrees of the same causes, insufficient secretion, or insufficient evacuation of excrementitious matters, are among the commonest sources of disorder; and it is by a proper restoration of these functions that the almost universal domestic remedies, as well as the common pills and draughts of the surgeon, prove so useful in preventing as well as in removing disease.

Numberless maladies arise from suppression or irregularity of the catamenial discharge; and diseases are not unfrequently excited or rendered active at the period of its total cessation. The same may be said of the secretion of milk. The disorders which these produce are commonly connected with local or general plethora.

69. An artificial or diseased discharge or secretion, as that of a seton or issue, or from an ulcer or diseased membrane, or an unnaturally profuse flow of an ordinary secretion—such as looseness of the bowels, if so long established as to have become habitual—cannot be suddenly suppressed without great risk of exciting disease. The same may be said of habitual hæmorrhages, as from the nose or rectum, and of the practice of periodical blood-letting. The maladies which result will vary with the predisposition; but generally they are of the nature of local or general vascular fulness, or some disorder of secretion or of the nervous system, arising from disturbances in the circulation. As examples may be named—congestion of the brain, apoplexy, congestion of the liver, various hæmorrhages and inflammations, gout, epilepsy, palsy, hysteria, hypochondriasis, mania, &c.

The suppression or too rapid removal of some cutaneous eruptions may be appended to this class. The diseases which it excites are sometimes inflammatory or profluvial, as gout, rheumatism, diarrhœa, &c.; sometimes more nervous, as chorea, epilepsy, asthma, dyspepsia, hysteria, &c.

70. (7.) Opposed to the group we have just considered, is *excessive evacuation* or *loss* either of blood or of some secretion. This was formerly noticed (§ 28) as a cause of debility, which predisposes to other diseases; but if the loss be great or sudden, it may produce immediate disease. A certain fulness of the heart and blood-vessels is required for their healthy functions, as well as for those of all the organs which they supply. If a moderate quantity of blood be suddenly withdrawn, or a large quantity less suddenly, the heart's action will be impaired, rendered irregular, and may be interrupted, and the brain not receiving a supply

sufficient for its functions, there may be fainting, with loss of consciousness, accompanied or followed by disordered function, palpitation, delirium, convulsion, or by death. The sudden impression in these cases is exercised more on the brain than on the heart; for these effects may be induced by the loss of a much smaller quantity of blood in an erect or sitting posture than in a horizontal posture. Similar results have been found to ensue from the sudden removal of pressure from the vessels in any considerable part of the body, as by the discharge of the fluid of ascites, or by enclosing a limb in an exhausting tube. (Dr. Arnott.) Lower mentions a case of extensive varix (enlargement) of the veins of the lower extremities, in which the patient could not stand without fainting, until the legs were bandaged. In these cases, much of the blood, although not removed from the system, gravitates into vessels, where it becomes unavailable for the general circulation. The fainting which occurs in these cases is called *cerebral syncope*, because the functions of the brain are suspended, consciousness is lost before the heart's action is interrupted; but the disorder of the brain reacts on the heart, and adds another influence to impair its action also. This is Dr. Alison's explanation. On the other hand, if the hæmorrhage is gradual, and the posture horizontal, other functions fail before the consciousness is lost—the chief symptoms being "feebleness of muscular action, paleness and collapse of the countenance, coldness, beginning at the extremities, cold sweat, beginning on the face, the pulse imperceptible," and the heart's action becoming so. The true nature of these effects, and of the reaction and nervous symptoms with which they are often followed, will be considered hereafter in connection with the subject of anæmia.

Not only blood-letting, but other evacuations, purging, sweating, and vomiting, the catamenial and seminal discharges in excess, are capable of producing syncope and general debility. The depression and faintness induced by these, although less prompt, are often more permanent than those from blood-letting; for such evacuations imply, not only reduction in the mass of blood, but also an exhaustion of the vital energies in the secretions and functions concerned in producing them.

The diseases gradually induced by these several causes of evacuation are seldom of a simple kind. General debility of the muscles and functions is commonly a result; but this is often complicated by symptoms of partial reaction, palpitation, spasms, noises in the head, images in the sight, pains in different parts, sometimes very acute, but seldom long fixed, partial paralysis, and a defective and disordered state of the excretions.

71. (8.) Of all the exciting causes of disease, there are none

so common as *temperature* in extremes, or in sudden transitions; cold, heat, and sudden transitions from cold to hot, or hot to cold. Both heat and cold have different modes of operation, and cause disease in different ways.

Extreme heat and extreme cold are directly destructive to life. Heat above 180° coagulates the albumen of the blood, and thus obstructs the blood-vessels, and may cause other chemical changes of a disorganizing nature, (§ 53:) a part that has been raised to this temperature, therefore, necessarily dies; it cannot live again. It is true that we occasionally see boiling water at 212°, boiling oil at 600, and ret hot iron at 1000°, produce no other effect than violent inflammation and blistering of a part; but that is because these bodies have been applied for too short a time to do more than violently stimulate the part, not time enough to raise it to the decomposing temperature; a few seconds more, and the part would be killed.

Cold below 32° freezes the water of the fluids; and as it destroys the life of tender plants, so it kills parts of animals, whether by the expansion of the ice injuring the delicate organization (Sir B. Brodie,) or whether from the mere stoppage of the circulation, or other cause, is unknown. The part may be afterwards separated from the living parts by a vital process of inflammation and sloughing.

72. A disorganizing degree of heat extensively applied acts like a violent mechanical injury—such as tearing off or crushing a limb, (§ 52.) It directly depresses all the functions: the pulse is very weak, frequent, and irregular; the muscular strength almost annihilated, and consciousness may be nearly or quite suspended. In this state, notwithstanding the stimulant properties of heat, and the inflammation which it generally excites, patients require stimulants, and they often die in a state of complete collapse, without any rallying or reaction. Extreme cold, also, if for some time applied to the whole body, depresses and paralyzes all its powers, even that of generating heat, and, therefore, of resisting cold. Sir Astley Cooper observed, that on plunging kittens into ice-cold water, the arterial blood did not become venous in the veins; and Chossat found, in animals killed by cold, arterial blood in the left cavities of the heart. From a similar cause, the limbs become benumbed by extreme or continued cold: thus persons are drowned in cold weather much more speedily than in warm. With less intense degrees of cold, on the other hand, which do not destroy the vital processes, more oxygen is absorbed, more carbonic acid formed, and heat generated, which are the means by which animals resist cold.

73. Heat which is insufficient to decompose is directly stimulant. It excites the functions of parts, and when generally applied,

induces a state of fever. Thus when a person is in a vapour bath, or hot air-bath, the pulse quickens, the whole surface becomes red, full, and hot; there may be throbbing and pain in the temples, and a feeling of feverish oppression, until a sweat breaks out, which relieves the superficial tension and fulness, and soon reduces the increased heat. Similar results may ensue from confinement in overheated rooms: and if there be any tendency to local congestion or inflammation, particularly in the head, this excitement may be enough to produce it. The continuance of heat enervates, reduces the strength and appetite, and may excite a feverish state, with disorders of the liver. The oppressed breathing which is often felt in heated rooms may, according to the view of Liebig, be ascribed to the smaller amount of oxygen in the air rarefied by the heat; but it is probable that this is not the only cause.

74. A more partial exposure of the body to heat may produce still more disordering effects, if the part overheated be capable of suffering from the excitement. Thus solar or artificial heat to the head may cause severe headache, apoplexy, or inflammation of the brain. Heat to the spine, as on sitting with the back near a large fire, is very apt to cause sickness and faintness, and, if continued, may induce convulsions. More local inflammations, as of the eye, ear, and skin, are frequently caused by exposure of the parts to heat. Gout may sometimes be excited in the feet by the same stimulus, and this is often attempted purposely.

75. Cold, on the other hand, is directly sedative. It contracts tissues and vessels, especially the arteries, and thus at first renders parts pale and shrunk. In persons of feeble circulation, after bathing, the fingers are sometimes quite bloodless and numb from this cause; the cold having quite closed up the arteries.* But cold also retards the passage of the blood in the capillaries; the viscidity of the liquor sanguinis seems to be increased; globules stick to the sides, or move but slowly, and the part soon becomes purple or blue from the congestion of blood in it. This purple colour is chiefly seen in parts much exposed, and where the blood habitually enters with freedom, as the cheeks, ears, nose, and hands. There is also much internal congestion from the intropulsive operation of the cold—that is, the external parts being constricted and obstructed, blood accumulates more in internal

* A similar effect may be seen under the microscope, on applying ice-cold water to the frog's web: the arteries contract to obliteration. This is contrary to the assertion of Poiseuille. (See my Gulstonian Lectures, Med. Gaz., July 16, 1841, p. 639.) It must be remarked that the elementary action of cold on the arteries is strictly stimulant, exciting their vital property of contraction; but its operation on textures and organs is sedative, because it impairs the circulation which supports their functions. So, too, we have found, that where it reaches the heart it paralyzes its powers, (§ 73.)

parts, and the heart's force is more expended on these. This may in part account for the degree of stupor and ultimate insensibility into which persons exposed to extreme cold are apt to fall. In some such cases there has been a flow of blood from the nostrils or ears: the stupor has continued for hours after the heat and circulation have been restored; and, in fatal cases, much serous effusion has been found in the brain.*

76. Hitherto we have considered the *immediate operation* of cold, (§ 73, 75.) But its indirect effects are more commonly known: these are, reaction, irritation, inflammation, and their consequences; and they will be more manifest where the cold has been partial, and the strength of the circulation generally not reduced. Thus, after a part has been exposed to severe cold, when restored to warmth, it becomes the seat of increased flow of blood, which causes redness, pain, and more heat; and various forms of inflammation may ensue, generally modified by the specific effect which the previous cold has exerted on the vessels and nerves; varying also with the strength of the general circulation. Thus, as the indirect effects of cold in a part, we may have chilblain, gangrenous or erysipelatous inflammation, and paralysis, or altered sensation. As much of the disease in these partial effects of cold arises from the violence of the reaction and inflammation, and this depends on the sudden return of heat and circulation in the part, it becomes an obvious indication, for frost-bitten limbs, to retard this return by cold applications. But Dr. Alison well remarks, that this precaution is not needed, where the sedative effects of cold have been more general; here warmth and stimulants may be used freely, for there is no fear of partial injurious reaction.

77. We have hitherto chiefly considered the manner in which cold causes disorder in the parts to which it is applied; but this is not the most common mode in which cold excites disease. A person gets his feet wet, stands in a draught of cold air, or is exposed to cold when insufficiently clothed; he afterwards becomes diseased—not in the feet, or the parts chilled, but in some *internal* part. He gets a sore throat, a "cold in the head" or chest, an inflammation of the lungs, a rheumatism in the limbs, a looseness of the bowels, a catarrh of the bladder, or any other disease to which he may be predisposed, (§ 14.) Now how does the *external* cold cause internal disease? How is the effect transferred from external to internal parts?

Dr. Alison supposes that the cold operates chiefly on the nerves, and that the sensation which it excites is conveyed also by the nerves to the internal organs, where its morbid effects become

* Kellie, Ed. Med. Journal, vol. i. p. 304, quoted by Dr. Alison.

manifest. But it must be objected that the morbific effects of cold are by no means proportioned to the sensation, or known nervous impression which it excites. A person may have his limbs aching and benumbed with general cold; yet internal disease does not result. But if he has been exerting himself, is perspiring, and then gets his feet wet, or is otherwise exposed to cold, especially partial, without continuing his exercise, although he may scarcely *feel* the cold, yet he will be pretty sure to *catch* cold, and to exhibit some one or other of its internal morbid effects.

It would seem more probable, therefore, that external cold excites internal disease by deranging the circulation, particularly that in the capillaries. Cold checks the external secretion, the perspiration; it constricts and obstructs the vessels of the surface (§ 75,) and must thus throw more blood inwardly, so that internal congestions are produced—these internal congestions may be the commencement of disease. This intropulsive effect of cold will take place more readily and to a greater extent in proportion to the weakness or relaxed state of the capillary circulation. This may be weak naturally, (§ 20;) in this case there is a constant liability to "take cold." Or it may be weak and relaxed from previous excitement, during fatigue (§ 23, 24,) or during sleep. Hence persons are more apt to catch cold after being in a hot room, after exertion, or when asleep. On the other hand, the injurious effect of cold is lessened or prevented by a vigorous state of the capillary circulation, whether that vigour be natural, or excited by continued exertion, stimulating drinks, or by febrile excitement, (§ 17.)

On this view we can understand why partial but continued cold, such as from draughts of cold air, wearing damp clothes, standing on cold stones and the like, should be particularly injurious, even when the sensation of cold excited is not great. Such causes of cold, acting long on the same part, more completely constrict its vessels, check its secretions, thus more surely injure the balance of the circulation, and by throwing a corresponding amount of congestion inwardly, fix it in some part predisposed to disease, (§ 14.)

78. When a person has thus taken cold, which he knows by general sensations of coldness and weak circulation, rather than by any feelings in the part chilled, powerful measures which tend to restore the balance of the circulation, such as violent exertion, a hot or vapour bath, or stimulant drinks, may often yet prevent the further progress of disease. The general application of cold, if not long continued, is less injurious than that which is partial, both because it disturbs less the balance of the circulation, and because also it supplies the lungs with denser air, and

therefore more oxygen; and its impression on the nerves of the face and chest excites more energetic respiratory movements, which maintain the heat and the vigour of the circulation. Healthy persons rarely take cold when travelling on the top of a coach or in a perfectly open carriage, but they frequently suffer in a close carriage partially open.

79. Susceptibility to the morbid effects of cold is to be diminished by means which invigorate the capillary circulation, especially those which promote that process of reaction by which cold is naturally resisted. Now nothing tends to increase this more than sudden artificial applications of cold, as by cold bathing or sponging, followed by friction, exercise, heat, or stimulant applications, which promote the reaction, (§ 16.) The great art in usefully applying cold with these intentions, consists in using the cold in such manner and degree, and having the body in such a state before and after the application, that the reaction or glow, which is the sign of vigour in the capillary circulation, shall be most fully produced. If, on the other hand, the cold be applied too long, or when the body is exhausted by fatigue, exertion or other cause, (§ 20,) or is naturally too weak, depressing effects of cold will continue, there will be little or no reaction, the sensations of langour and chilliness show that the cold has been injurious instead of beneficial. The addition of salt to the water of baths gives it a stimulant property which promotes reaction, and a similar influence results from the force or shock with which the water is applied. This shock excites deep and forcible respirations through an impression on the incident nerves; and these are probably the efficient cause of the process of reaction which follows.

The reaction which follows the judicious use of cold as a therapeutic agent, may prove serviceable, not only in resisting the further influence of cold, but also to remove congestions and irregularities in the circulation from other causes, and to excite in the capillaries and secernents new actions, which may supersede those of disease. It is thus that the "water cure" of Priessnitz chiefly operates; and although too powerful an agent to be entrusted to unskilled and unscientific hands, it promises to become a valuable addition to the means of combating diseases, particularly of a chronic kind.

In the preceding remarks on cold, it must be borne in mind that the term cold is applied relatively, not absolutely; cold is not a fixed temperature or range of temperature; but something considerably below the temperature of the body. Thus a body that has been warmed throughout to a heat of 98°, and kept in an excited state by that temperature, would suffer from a draught of air at 70°, which would be cold to the body, and produce the physiological and pathological effects of cold. But if the body had not been previously warmed, so that the temperature of most parts of the surface might not exceed 85°, or if although lately warmed, the energies of the body had not been exhausted by it, then air at 70° would feel pleasant, and produce none of the effects of cold. This is one of many facts which distinguish vital from physical properties. Physical or chemical properties are generally affected by fixed temperatures, independent of previous circumstances: but vital properties are variously affected, through that power of adaptation by which they are enabled to maintain the same function in varying external circumstances.

SECTION IV.

II. NONCOGNIZABLE AGENTS.

80. We now proceed to notice those causes of disease, the existence of which is inferred only from the fact that disease prevails under certain circumstances not well explained, unless we assume that such causes do exist, (§ 12,) although we cannot prove their existence in any other way, (§ 53.) These comprise the *endemic*, *epidemic*, and *infectious* causes of disease.

I. ENDEMIC CAUSES.

81. Persons living in a marshy district are often afflicted by a disease called *ague*, which does not attack those inhabiting dry lanes. Again, the inhabitants of certain deep valleys are often affected with the swelling in the neck, called bronchocele or goître: the neighbouring mountaineers are not so affected; and when those from below remove their residence to the mountains, they often lose the disease. These are instances of diseases which may be said to dwell among the residents in particular spots; hence they are called *endemic*, *in* the people, (εν δημος.)

82. In some cases, much doubt still hangs over the precise source of endemic influence; some supposing it to be in the water, others in emanations from the soil; but this doubt does not apply to the cause of agues, intermittent and remittent fevers, which have been clearly traced to effluvia from marshes, rice-grounds, &c. It has been found that when the wind blows across these marshes, the disease appears chiefly in persons residing to leeward of them, and not to windward; and it has been abundantly proved, that when the marshes are drained the ague

ceases. From these and similar facts, it is concluded that the cause of the ague is an *effluvium*, *miasm*, *malaria*, or bad air; an *aerial poison*, which is supposed to be inhaled with the breath, and absorbed into the system.

83. The true nature of marsh malaria has not been determined. It has never been detected by chemical analysis. Professor Daniel conjectured that the malaria causing the destructive endemic fevers of Western Africa, might be sulphuretted hydrogen evolved from the sea-water by the decomposing vegetable matter brought down by the rivers; but I am informed by Dr. D. B. Reid, that experiments made in the late unfortunate expedition to the Niger have negatived this notion. The microscope, rather than chemical analysis, may be expected to discover the nature of malaria.

Although hitherto unknown in its nature, some knowledge of the general properties of marsh malaria has been obtained through its morbific effects. It seems to be heavier than air; for persons occupying a ground floor suffer more than those living in upper apartments. Water seems to absorb or destroy it; for persons on board ship, or on an opposite side of a lake, are not affected; whilst at a greater distance a favourable wind will convey the pernicious influence over land. A damp state of the air, however, favours its production; good fires in a house give marked protection to the inmates. It seems to be attracted by trees; for the vicinity of trees is doubly dangerous, whilst places beyond trees are more free from its effects than others at the same distance.

84. The chief points known with regard to the source of malaria are, that it arises from the operation of the sun's heat on marshy ground, or on the banks or deltas of tideless rivers, after evaporation has proceeded to some extent; putrefaction of organic matter not being an essential part of the process.* The virulence of the malaria, as shown in the severity of the disease excited, and in the number which it affects, seems to bear some proportion to the heat which has led to its development. Thus the ague of this country, the pernicious intermittent of Italy, and the malignant remittent of Western Africa and the West Indies, seem to arise from similar endemic causes, but differing in their virulence according to the degree of heat. A certain amount of moisture is, however, required; for a very dry season which desiccates a marsh, stops the malaria; and the deposit of the evening dew always favours its production, (§ 83.) Again, excess of moisture checks its development, so that a very wet

* Chisholm and Ferguson, Ed. Med. and Surg. Journal, vol. vi.; Trans. Roy. Soc. Edin., vol. ix.

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season, as well as a very dry one, may render a marsh less unhealthy, (§ 83.) Extreme heat will not, however, diminish the malaria from the banks of rivers, since portions of these are never dry.

It is not only marshy or low grounds that engender malaria, although these are the situations commonly most favourable for its production. All that seems to be requisite is the continued operation of the sun's heat on moisture stagnant at or near the surface of the ground. I know instances in which ague has attacked persons living on a height of mountain limestone, forming a small table land below greater heights. So also some swampy lands are not malarious, particularly peat bogs, which show a remarkable exemption from decomposition and effluvia of all kinds.

85. The morbid effects of marsh miasms are several: intermittent and remittent fevers of various types are the most remarkable of these, and they particularly affect the new residents; but the older inhabitants suffer from diseases of the liver and spleen, nervous affections, rheumatisms, dropsy, and cachectic complaints, and are generally short-lived.

One of the most remarkable characters in the diseases resulting from malaria is the periodicity of their attacks, and the diminution or cessation of the symptoms in the interval.

86. There can be little doubt that there are different kinds of malaria besides that which causes intermittent and remittent fever, (§ 79, 81.) Thus yellow fever and plague are endemic diseases, probably arising from peculiar aerial poisons. The propagation and mortality of the latter, perhaps its very existence, is very much to be ascribed to the filth and impurities of the towns where it prevails. There is now abundant evidence that drains, cesspools, and other repositories for effete and putrefying organic matter, evolve exhalations which, when concentrated, may generate low fevers; and when more diluted, may considerably impair the health of those exposed to them,* (§ 22.)

87. Some other endemic diseases can be traced to more cognizable causes; as the Guinea worm, to drinking water containing its ova; the pellagra of northern Italy, and the plica of Poland, to neglect of cleanliness and healthy modes of living.

II. EPIDEMIC CAUSES.

88. There is another class of diseases, which, in their affecting many persons in the same place and at the same time, resemble the endemic, (§ 81.) But they differ in this respect, that they do

* Sanatory Report of the Poor-Law Commissioners, by Mr. E. Chadwick, 1842.

x or as Dr [illegible] expressed it the diseases of the season assumed the type of the prevailing epidemic.

not regularly return at stated seasons, (§ 84,) nor are they confined to particular localities, (§ 82,) although they infest some more than others; but they attack a whole district, a whole country—nay, almost a whole hemisphere—within a very short time; often coming on without obvious cause; prevailing for some time, then disappearing for an uncertain period; perhaps recurring within a few months, or years, or not within the memory of man. These are called epidemics, (επιδημος,) like a blight or pernicious influence blowing *on the people;* and therefore affecting a whole country at once.

89. The cause of these diseases is supposed to be something in the atmosphere; because the atmosphere is the only thing common to all the places so affected; but the nature of the cause is not known. It is true that some diseases, which seem to prevail epidemically, may be traced to the cognizable qualities, cold, heat, dryness, and moisture of the air, (§ 72, *et seq.*) Thus diseases excited by cold, sometimes prevail, like an epidemic, in the winter; those by heat, in the summer; catarrh and quinsies abound in cold damp weather; croup and rheumatism become common during the prevalence of a cold east wind, in the spring; diarrhœa and dysentery are rife in the fruit season of the autumn. Others again, such as dysenteries, fevers, scurvies, &c., have in some instances obviously arisen from deficient or contaminated food, bad water, or some distinctly cognizable cause, (§ 60, 66.) And as these causes belong to the class of cognizable agents before noticed, (§ 51, *et seq.*) it is unnecessary to advert to them here.

90. But there are diseases occurring epidemically without any discoverable connection with season or temperature. Thus an epidemic influenza may come on at any season of the year, rapidly spread through a country, and cease as unaccountably as it began. So, too, diseases that are usually excited by other causes, infectious and others—such as, typhus and scarlet fevers, measles, small-pox, erysipelas, &c.—sometimes prevail throughout a country so generally, and often with such peculiar characters, that some influence besides their common causes must be concerned in their sudden increase. The nature of this influence is unknown; but it is called *epidemic*, (§ 88.)

91. Lastly: various diseases, fevers, and inflammations, and almost all sorts of ailment, at some periods assume a remarkable character in common, or *type*, (as it is called;) for example, being attended with unusual weakness, or unusual excitement, or a tendency to hæmorrhage. This is called an *epidemic* or *prevailing diathesis*, or *constitution*. Thus at uncertain times, fevers, wherever arising, and from whatever source, are more low, typhoid, or adynamic, than usual; at the same time, exanthematous diseases generally partake of the same character; and even pa-

tients affected with inflammations do not well bear the usual depletions. Of late years, this constitution has more or less prevailed, and may be contrasted with a period of twenty years ago, when an inflammatory diathesis existed, and blood-letting was advantageously employed even in continued fever.

92. It has been before stated, (§ 89,) that we are quite in the dark as to the nature of epidemic influences, or causes of disease. Many conjectures have been advanced, some of them with much plausibility, but without any substantial support. Dr. Prout states that, shortly before and during the prevalence of the malignant cholera in this country, he noticed a small but decided increase in the average weight of the atmosphere, as if from the addition of some ponderous gas. At the same time, he remarked an unusual acidity in the saliva even of healthy persons, and such an absence of lithic acid from the urine, that he seems inclined to suppose that a disposition to form oxalic acid was referable to the same unknown cause which was then producing cholera, (§ 56.)

Many analogical arguments may be adduced in favour of the notion that epidemic diseases are caused by animalcule tribes. This hypothesis has been ably advocated by Dr. Holland* and Dr. Henle.† Before I had seen the opinions of these authors, I had stated in my lectures some arguments in favour of this notion, which will be given under the head of infection. The chief facts which countenance this view are the following:—1. Epidemic diseases in the uncertain periods and places in which their visitations occur, (§ 88,) resemble those of blights, or tribes of insects, which are known to appear and disappear without evident cause. 2. Proofs are accumulating of the occasional existence of parasitic animals and plants in living animals, and in some instances as causes of disease; (as in the case of worms and other entozoa, acari in itch, the rot-worm in sheep, the mycodermatous vegetations in porrigo,‡ confervæ in impetigo, aphthæ, &c.) 3. The history and symptoms of some epidemic diseases, such as cholera and influenza, are not inconsistent with the hypothesis that they are caused by the sudden development of animalcules from ova in the blood. But there is a total want of direct observation in support of the hypothesis; and, perhaps, it may be objected against it, that the seasons at which epidemics sometimes appear (as cholera in winter) are not always those most favourable to the development of animalcule life.§

* Medical Notes and Reflections, 1840, p. 597.

† Pathological Researches, British and Foreign Medical Review, April, 1840.

‡ Gruby, Comptes Rendus, t. xiii. Bennett, Trans. Royal Soc. Edin., 1842.

§ The prevalence of the south-east wind was observed to be particularly favourable to the increase of both cholera and influenza; and I cannot but think

III. INFECTIOUS CAUSES.

93. The terms *infection* and *contagion* are applied to the production of a disease by a morbid matter proceeding from the body of another person who is, or has been, the subject of the same disease. The proofs that disease is thus propagated from one individual to another are, first, the general one, that those who have intercourse with the sick are affected in much greater numbers than those who have not, (§ 12;) and, secondly, the direct and individual proof of infecting a healthy person with matter taken from a person in disease. This, although available only in some modes of infection, may be considered as a proof of the fact of contagion in general—that is, of disease propagating its kind.

94. I have just alluded, (§ 93,) to differences in modes of infection: they may be further enumerated as follows:—

(1.) Infection through wounds, or an abraded surface; as in hydrophobia, the morbid matter being contained in the saliva, or guttural mucus of the rabid animal; and in cow-pox, the matter being contained in the specific vesicle, and acting on a puncture or abraded surface.

95. (2.) Infection by contact, different parts of the body being susceptible in different diseases; as the urethra and conjunctiva in gonorrhœa, the vicinity of the external openings of the passages in syphilis, the skin in scabies, the scalp in porrigo—the morbid matter generally proceeding from similar parts.

96. (3.) Infection by exhalation from the breath, perspiration, or other secretion, conveyed through the air to the mouth and air-passages; as in the case of measles, scarlatina, hooping-cough, typhus, and other infectious fevers.

97. Some diseases may be propagated in several of these modes; small-pox, for instance, may be communicated by punctures in the skin, (§ 94,) by inoculation—application to the eye, (§ 95,)—and by diffusion through the air, (§ 96:) and probably the same might be effected with other febrile poisons, if their precise source in the body were as clear as it is in small-pox. These different modes of infection merely show that the infecting matter can exist suspended in the air, as well as in a fluid or solid state; and according to these conditions, it may get access to the system by different avenues.

that this had some connection with the general tendency exhibited by the former to spread chiefly from east to west. Has the morbific property of this wind aught to do with the haziness of the air when it prevails—a haziness seen in the country remote from smoke, and quite distinct from fog? What is this haze? In the west of England, a hazy day in spring is called a *blight*.

98. Many of those who are skeptical as to the reality of infection, aim their objections only against aerial infection, and do not question the other modes. But the difficult problem is, not that the infectious matter may be diffused through the air—our smell informs us that animal effluvia are constantly so diffused—but the difficulty lies in the fact of infection by any mode; that is, that disease should propagate its kind. There are only two parallel cases in nature, in which analogous properties are possessed by matter. One is the case of what is called septic matter, leaven, or ferment; a little of which introduced into organized matter will promote changes and decompositions—"A little leaven leaveneth the whole lump." This property is supposed, by Liebig and other chemists, to be chemical, operating in the manner of heat, by altering the molecular relations of compound matter; but by Cagniard De la Tour and other microscopic observers, it is stated, that fermentation is caused by the production and growth of living molecules or vegetables, and that it spreads by the propagating power of these. This would transfer this case, that of leaven or ferment, into the next category, (§ 99.)

99. The other case analogous to propagation of disease by infection, is the vital power of generation; in this case, as in that of contagion, matter propagates its own kind in the animal and in the vegetable world. Does the matter of contagion consist of animal ova or vegetable seeds? Are infectious diseases the results of the invasions and operations of living parasites disturbing in sundry ways the functions and structures of the body, each after its own kind, until the vital powers either fail, or succeed in dispelling the invading tribes from the system? (§ 16.) Such an opinion has been many times proposed, and is, in a degree, implied in the term *incubation*, (sitting on eggs to hatch them,) commonly applied to the period between the reception of the infection and the first appearance of the symptoms. In support of this notion may be adduced the case of itch, which certainly infects by its cause, the itch-mite, and spreads by this animal's propagation; and the case of porrigo, or favus, which probably depends on a parasitic vegetable, and infects through the seeds or sporules of this vegetable.* But these, it may be objected, are instances of mere local disease, and by no means like the cases of infectious fevers and syphilis, which affect the whole system.

The case of small-pox and cow-pox might seem to be more intelligible, because the infectious matter is found to reside in the incipient pustule; but this throws no further light on the subject; for the lymph of these vesicles has not been hitherto found to con-

* Schönlein, Müller's Archiv., 1839, p. 82. Gruby, Gazette Medicale, Juillet 17, 1841.

tain any thing which can account for its disseminating property. The microscope should solve this problem, by detecting the germs and growths of these infecting organisms, if such exist. Until this be accomplished, the nature of contagion must remain a matter of speculation.

100. The parasitic nature of infectious matters may receive some support from the little that is known of their general properties, which further deserve to be mentioned on account of their practical importance. Infectious matter is destroyed by a temperature above 120° Fahr., and by strong chemical agents, especially chlorine: its activity is impaired by cold; and in case of aerial infection, by intense cold and free ventilation it is rendered harmless. Hence infectious diseases usually cease when hard frost sets in. On the other hand, warmth, closeness, and filth, increase the virulence of contagion, and become, as it were, a hotbed of pestilence. Nothing tends to promote the spread of an infectious disease more than crowding together several who are suffering under it. Each one is a separate source of contagion; and if these sources are multiplied in an apartment, the air will be contaminated in proportion. I believe this to be the chief reason why, in fever hospitals and fever wards, medical attendants and nurses escape infection much more rarely than in hospitals where the fever patients are widely distributed among other patients.

It may be useful again to point out the peculiarities which distinguish infections from endemic and epidemic diseases; for these peculiarities are proofs of the reality of infection as a separate cause of disease.

101. *Infectious* diseases first attack individuals in any locality, then gradually spread in the vicinity of those diseased, or in the direction where there is most human intercourse. Where care is taken, early and completely to separate the diseased from the healthy, disease does not appear among the latter.

102. *Endemic* diseases may simultaneously attack many individuals in certain localities only, (§ 81); they do not spread beyond these localities; no separation of the sick from the healthy will save the latter, but removing the healthy to another spot gives them security.

103. *Epidemic* diseases simultaneously attack numbers in any locality, (§ 88:) they increase not peculiarly in the vicinity of those first affected, nor in proportion to intercourse with them, but rather in proportion to the prevalence of other causes that may be called predisposing or determining causes, (§ 19.)

104. It must not be forgotten that some diseases are suspected to originate and spread in two or even all of these modes. Per-

haps this may be said of typhus fever, plague, cholera, and dysentery. It has been already mentioned that infectious diseases, as small-pox, scarlatina, and measles, are occasionally increased and modified by epidemic influences, (§ 90, 91;) and the same thing may be said of some endemic maladies. So also the aggravation of contagious and epidemic complaints by endemic impurities, (§ 85,) makes it plain that all the class of causes may operate conjointly. It is under such circumstances of aggravation, or under those of strongly prevailing predispositions, as from famine, (§ 21,) fatigue, (§ 23,) confinement, (§ 22,) or mental depression, (§ 27,) that this class of diseases become so destructive as to be called pestilential or malignant.

105. The direct operation of most of this class of causes is depressing, and where they are strongest and prevail most, the resulting disease is one of depression, *adynamia*, *asthenia*, or prostration of the vital powers. These causes are therefore commonly designated *specific poisons*. But there is the antagonist principle of vital resistance in the system, (§ 16,) which leads to various processes of reaction, which may be exhibited in different degrees, according to the relative strengths of the poison and of this resisting power; and likewise often according to various cognizable agents which simultaneously act as predisposing, determining, or co-operating causes. For instance, in warm weather the poisonous influences are generally strong, (§ 84, 100,) and the bodily powers weak, (§ 24;) the resulting disease is one of more complete adynamia. In moderately cold weather, on the other hand, the specific poison is less active, and the system is ready to react, not only against it, but against the cold with which it may be combined; this causes a more inflammatory type in the consequent disease, (§ 76, 77.)

CHAPTER II.

PATHOLOGY (PROPER)—THE NATURE AND CONSTITUTION OF DISEASE.

106. DISEASE is a change from the natural condition of the function or structure of the body, (§ 6, *et seq.*;) but the change is generally more or less compound, involving several elementary functions or structures; and it is obvious that we cannot obtain an accurate knowledge of the nature of disease until we have ascertained that of its component parts. As the anatomist and physiologist examine structure and functions by separating or analyzing them into their constituent parts, before he contemplates them in combination, so should the pathologist study these constituent parts, or elements, in *disease,* before he can understand their combinations.*

The chemist, in the examination of his subjects, finds that there are some principles or elements that cannot be analyzed or divided further; these he calls ultimate or primary elements: others, again, are simple compounds, which may be analyzed; but they occur so constantly, and act so singly in compounding and giving properties to complex matter, that they are called proximate principles or secondary elements. A parallel case might be shown of physical science.

107. So it should be with physiology and pathology.† There are the healthy and diseased *primary* or *ultimate elements* of *structure*—muscular fibre, nervous matter, vascular fibre, and

* A neglect of this precept has greatly retarded the advancement, nay, even the formation, of pathological science. Men have begun with the very complex problems of *inflammation* and *fever,* before they have made themselves acquainted with the elementary properties of textures, or even of vessels. The result has been, that the most profound reasoning and ingenious speculations have been wasted on nonentities, such as spasm of the extreme vessels, increased action of the capillaries, &c.; and even observation has been confused by the complexity of the subjects brought under it.

† I have pursued this synthetic mode of teaching general pathology, in my lectures, during the last three years. I am not aware that it has been fully used by any other writer, although several (as Andral and Carswell) have partially recognized it in their divisions of the objects of morbid anatomy; and my friend, Dr. Symonds, has adverted to the parallel of chemistry, and actually employed the term, proximate principles of disease, in the same sense in which I use it.—*Library of Practical Medicine,* vol. i., *Pathological Introduction.*

the elementary tissues of membranes, glands, skin, and other parts; and there are *primary elements,* healthy and diseased, of *function* of these same structures—irritability, tonicity, nervous properties, to which may be added, because at present we cannot analyze it, the power of secretion and nutrition; and lastly, the constituents of the blood. And there are the *secondary* or *proximate elements* of disease, composed of the preceding primary elements, but still simple in comparison with the complex conditions of disease which they combine to produce.

108. The following are the chief of these proximate elements: the blood-vessels and their different conditions, anæmia, plethora, congestion, determination of blood, and inflammation; the nervous system, with its different functions, sensation, volition, reflected excitement, sympathy, and irritation; the secreting organs and membranes, with their relations to the vessels, the nerves, and to the purposes which the secretions serve in the animal economy: lastly, (and here we must drop physiology, for the subject is peculiar to pathology,) the elements of structural diseases, new formations, and parasitic creatures.

These, with a few more of less importance, constitute the secondary or proximate elements of physiology and pathology: we have to consider them in relation to pathology only.

109. These primary and secondary elements of disease are the especial subjects of general pathology. By the study of them we become acquainted with the materials of disease, and their relations to each other; we learn how special diseases arise, and of what they consist; how they produce their phenomena and effects, how they are to be known, distinguished, and classified. Out of such a knowledge, where it is correct, sufficient, and combined with an ample acquaintance with the properties of remedial agents, arises the rational method of relieving, curing, and preventing disease, the great ends of the art of medicine.

I readily admit that our knowledge of these elements, these principles in pathology, is as yet too limited to be entitled to rank as a science; but I think that the attempt to describe and illustrate them will be useful, not only by making available all that is known on the subject, but also by showing what is not known, and needs investigation: thus suggesting fit subjects for further research.

FUNCTIONAL OR DYNAMIC DISEASES.

PRIMARY ELEMENTS.

SECTION I.

PROPERTIES OF THE MOVING FIBRE.—IRRITABILITY.

110. Irritability, irritable contractility, or the property of contracting on the application of a stimulus or exciting agent, is the distinctive property of muscular fibre. Although some physiologists maintain that this property is derived from some part of the nervous system, they have not produced any conclusive proof; it is therefore more philosophical to retain the Hallerian view of intrinsic irritability.*

111. It may become *excessive*, so that the contraction is too violent for the welfare of the part or of the system. This constitutes spasm or convulsion. The excess of irritability may be manifest in three ways:—1. By an excessive strength and degree; 2. By an inordinate quickness or promptitude; 3. By the unusual duration of the contractions.

112. (1.) Excessive strength of muscular contraction is exemplified in the violent action of the heart during exertion or other excitement; and in the extraordinary muscular power of a delirious patient, who can master persons naturally stronger than himself. This exaltation of the natural property may depend on the excessive stimulus, as of blood in the heart, or of nervous excitement in the case of the delirious patient; or it may arise from the muscles being over-fed with blood.

113. (2.) Inordinate readiness or quickness of contraction constitutes mobility of muscle, a slight stimulus causing it to con-

* Dr. M. Hall ascribes irritability to the spinal marrow; but he mentions an experiment which is conclusive against this view:—"During the half lethargic condition of the frog in winter, the entire cerebrum and spinal marrow may be removed, by slow degrees, at considerable intervals; the circulation is nevertheless good."—Gulstonian Lectures, 1842, p. 60. The irritability of the heart, therefore, is unimpaired. The late experiments of Dr. John Reid, on muscular irritability, are strongly in support of the Hallerian doctrine.

tract. This often coexists with want of power or completeness in the contractions. It is exemplified in the irritable heart, which, although acting very frequently, does not expel its contents so vigorously as in health. It is seen in the quick nervous movements of irritable persons, who are at the same time weak. The bowels show it in that irritable looseness formerly called lientery, in which food is quickly passed little altered; and it is instanced in the irritable bladder, which will not hold even an ounce of urine. The pathological cause of this kind of inordinate irritability is either an undue flow of blood to the muscle, which exalts its natural property, or a predominance of irregular nervous influence, which unduly excites this property: thus it is often excited by irritations of the motor nerves, or of their columns or fibres. But the most remarkable examples are given in the extreme case of *convulsions* or *clonic spasms*—that is, sudden contraction, alternating with relaxation, as seen in chorea, epilepsy, and convulsive hysteria, where it affects the voluntary muscles; and in the palpitating heart, which beats irregularly, and out of rhythm.

114. (3.) An unusual duration of muscular contraction constitutes *tonic spasm* or *cramp*, in which the contraction is strong, and not alternated, as usual, with relaxation. Such spasms are not unfrequently felt in the calves of the legs; and the different muscular canals, the gullet, stomach, the intestines, and the glottis, occasionally present this state of continued contraction. In most of these cases, it is accompanied by pain more or less severe, and may lead to serious obstruction to the function of the organ. When in a more moderate degree affecting the voluntary muscles generally, it constitutes catalepsy, in which, from the muscles remaining contracted, the limbs will retain whatsoever attitude they are placed in, until the spasm is over. But the extreme example is tetanus, in which the spasms are so violent and so enduring, that they may be said to squeeze the patient to death. The pathological cause may be, as in other modifications of irritability, either an irregular supply of blood to the part, or irritation, direct or indirect, of the motor nerves by which the muscles are excited.

115. *Remedial measures.*—These must depend on the cause of the excessive irritability. Where this is increased flow of blood to the part, blood-letting, derivants, sedatives, and other remedies for determination of blood, may be proper. Where the cause is nervous irritation, narcotics are the most effectual; and some of these, from their peculiar efficacy in allaying spasm, are called antispasmodics. The most powerful of these are stramonium, belladonna, sulphuric æther, opium, and Indian hemp. Where irritability is combined with weakness, tonics are often serviceable, especially the metallic tonics, and bark.

116. Muscular contractility may be *defective* chiefly in two modes. 1. In force, (§ 112;) as in the weakness of voluntary muscles, during severe illness, after fatigue, (§ 68;) or under the influence of a depressing poison or shock, (§ 55;) and in the weakness of the heart under similar circumstances, and in faintness, or in the sinking which precedes death. This weakness is caused by the exhaustion of previous exertion, or by want of a due supply of blood, which is necessary to maintain all functions; or it may proceed from an influence positively depressing or destroying the muscular power, as in the case of sedative poisons, as tobacco, sulphuretted hydrogen, &c., and probably concussion and other violent injuries to the organization. The extreme effect of these agents is to cause paralysis, or complete loss of irritability, which, affecting the heart, constitutes death by syncope. Muscles sometimes lose their irritability by more gradual causes, such as rheumatic inflammation, the action of lead, &c. Various muscles are reduced in power by over-excitement or exertion: this is exemplified in the paralysis of the sphincter after over-distension of the bladder, torpor of the bowels after the operation of an active purgative, &c.

117. (2.) Muscular irritability may be deficient in readiness to contract, (§ 113,) as in the sluggish movements of a person whose irritability has been lowered by opium; and in the slow pulse caused by digitalis, and by some cerebral affections; and in some cases by blood-letting or low diet. It is by no means clear why the same agents should lower in some cases the strength, and in others the promptitude in contraction; and in many other respects, the laws of irritability require further investigation.

118. Although it has never been proved that muscular irritability is *derived* from the nervous system, yet the illustrations already given plainly point out that it is much under its influence. The nerves are the proper medium by which the voluntary muscles are made to act, and through the nerves the motions of the involuntary muscles are influenced, as instanced in the operation of mental emotion on the action of the heart, (§ 69.) Hence diseases of muscular action generally rank with nervous diseases. Thus disease of the brain may cause a cessation of muscular motion by suspending volition; and disease of the spinal marrow or nerves may do so by intercepting the influence of the will: in either case, muscular motion ceases, not from disease in itself, but for want of its proper stimulus, the will. In fact, under these circumstances, muscular irritability sometimes accumulates, (§ 111,) and is brought into action, by slight impressions reflected from the spinal marrow. Thus, in complete paraplegia, or loss of motion of the lower half of the body, convulsive movements

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may be excited in the lower extremities by tickling the soles of the feet: in other cases of paralysis, they may be produced by electricity.

119. *Remedial measures.*—As usual, these will vary with the cause of the defective irritability; where it proceeds from exhaustion, repose is the obvious indication. But even here, in extreme cases, and more particularly in those in the second head, (§ 117,) it may be necessary at once to excite the defective irritability by stimulants, especially those of the more diffusible kind, as ammonia, brandy, and other spirits and essential oils; whilst the feeble circulation may be aided by heat and frictions. The large quantity of stimulants borne by patients whose irritability is reduced by accident or disease, is a remarkable feature in their history. A person faint from great loss of blood, (§ 71,) a crushed limb, (§ 55,) or a sedative poison, will bear four or five times more brandy than would be sufficient to intoxicate him under other circumstances. Electricity and the dash of cold water should be mentioned among temporary means of exciting defective irritability. Strychnia and cantharides are reputed to restore power to paralyzed muscles.

SECTION II.

TONICITY.

120. TONICITY, or tone, is a property possessed by all muscular structures, and by some which are hardly accounted muscular. It is a tendency to slow, moderate contraction, not essentially terminating in relaxation; but it keeps the parts in which it resides in a certain degree of tension. This tone keeps muscles and limbs in their places when at rest, and out of their places when dislocated: if one set of muscles is paralyzed, the tone of their antagonists draws the parts in an opposite direction, as we see in paralysis of the portio dura on one side of the face. A similar property is possessed by the intestinal tube, the urinary bladder, the air-tubes, and the middle coat of the arteries, and gives them a constant tendency to contract on their contents. In these, but particularly in the arteries, it performs an important part, both in health and in disease. By this the arteries contract, when they cease to receive blood from the heart, and thus are found empty after death. It adapts them to different degrees of fulness, yet maintains a certain tension favourable to equality in the motion of the blood.

It has been asserted, that tonicity is quite distinct from irritability; and although irritable fibres possess tone, tonic textures are not irritable. This is not true with regard to the arteries; for I have many times distinctly seen them slowly contract, and remain contracted, at a point to which an irritant, mechanical, chemical, or electric, has been applied. The late discovery, by Henle, of a structure distinctly muscular in arteries, confirms this observation. I have proved, in like manner, the irritability of the air-tubes, which move more readily under a stimulus than the arteries; whilst that of the intestines is still higher in degree, but still inferior to that of the œsophagus and voluntary muscles, the contractions of which, on the application of a stimulus, are abrupt, and immediately followed by relaxation. So far, then, it appears, that tonicity is influenced by the same agents which excite irritability; but another agent, temperature, seems to affect them differently, (§ 74, 75.) Cold increases tonicity and impairs irritability, whilst heat diminishes tonicity and increases irritability. Under the influence of cold, arteries shrink in size very remarkably;* and the muscles and other textures present a firmness and contraction which impede the quickness of motion characterizing the highest degrees of irritability. Under the influence of heat, on the other hand, although muscles are relaxed, they are more irritable, and the pulsations of the heart are more frequent.

Cold and heat, therefore, become the best tests for tonicity; and by their means we find this property to be possessed by textures which have never been proved to be irritable; I mean, the veins and the cutis, which contract with cold, and become relaxed with heat.

Now this property, tonicity, is a very important one in the animal economy, its natural condition being very necessary for the preservation of health, and its modifications being concerned in causing and constituting disease. Practical men have long admitted the existence of something of this kind, without defining or localizing it; and the terms tone and atony, bracing and relaxation, tonic and relaxing remedies, become quite appropriate in connection with this property. Let us notice some of the characters of its *excess* and *defect*.

121. Where there is an *excess of tonicity*, the muscles are so firm that there is scarcely room for free motion; the pulse is strong, tense, and often slow, yet there is scarcely any interval

* This fact must be familiar to every one who has noticed the difference of the pulse when a limb is cold and when it is warm. But I have seen it more forcibly illustrated by experiment. On plunging into cold water the aorta of an ass just dead, it contracted so closely as to obliterate its cavity; and it required some force to pass the little finger into it. The crimping of the flesh of fish is referable to the same principle.

between the heart's beat and the radial pulse. The capillary circulation is active, and the extremities warm; but owing to the tense state of the vessels and of the skin, the secreting organs do not act freely, the urine is high coloured, the bowels are disposed to be costive, and the skin to be dry and hot. This is a condition leading to sthenic plethora or local congestion, active hæmorrhage or inflammation, apoplexy and gout; but there is less than usual proclivity to infectious diseases and others of a depressing character.

122. *Remedial measures.*—In such a state blood-letting is but a temporary remedy. As long as the tonic fibres are too much braced, the secretions will be defective, and the vessels will fill again and renew the danger. The measures best suited for this state of excessive tone are those tending to relax the tonic fibre, and increase the secretions, such as warm bathing, exercise, sudorifics, aperients, and diuretics, with moderate diet. It is probable that some remedies, such as antimony, reduce directly the tone of the vascular fibre, acting as relaxants. We shall have to advert to this subject again under the head of inflammatory fever, of which the element, excessive tone of the vascular system, is a chief constituent.

123. Where tonicity *is defective*, the muscles are flabby and incapable of continued exertion, but sometimes are too irritable, with the tremulousness of debility, (§ 113.) The heart likewise is irritable, and often exhausts its strength in palpitation; the pulse is soft and unsteady; it may be full when slow, but it is without strength, and easily accelerated. Its most distinctive character, however, is its retardation, increasing the interval between the heart's beat and distant pulses; so that the radial pulse is often felt after the second sound of the heart is heard; (§ 121:) the tubes being less tense, the pulsewave is slower than usual, (§ 120.) So too the loose relaxed state of the vessels renders the circulation in distant parts weak, so that the extremities are cold, whilst the head may be congested. Sudden exertion or change of posture may disturb the circulation and cause faintness or giddiness. Want of tone also in the stomach and intestines causes indigestion and costiveness, and permits them to become distended with wind and accumulating fæces. The secreting organs, irregularly supplied with blood, are also liable to disorder, being either scanty, depraved, or profuse and watery.

It is quite obvious that a person in such a condition must be prone to various diseases. He has no resisting power (§ 16) against malaria, infection, or other depressing agents. If he is exposed to cold, the blood is readily driven through the weak vessels into the interior, (§ 77,) where it causes congestion or inflammation. The weak intestines have no power to expel offending matter from them, (§ 57.) Thus the system in a state of atony is open to the action of many exciting causes of disease; besides being itself in many respects on the very verge of disease.

124. *Remedial measures.*—The proper remedies in such a condition are tonics, or those agents that tend to increase the tone of the system, (§ 120,) particularly of its muscular and vascular parts. We have already stated that cold has this effect in a marked degree, (§ 79;) and in truth, cold, properly applied, is one of the best tonics which we possess. For this purpose its application should be sudden, and too brief to cause depression or any of its morbid effects. The shower-bath and plunge-bath are the most effectual forms; and free sponging, with cold salt water, is applicable even to weak subjects. A pure bracing air and much exposure to it have also useful tonic effects. There are many medicinal tonics, the most effectual of which are bark and its preparations, medicines containing iron, and the mineral acids. Generous living may be considered a part of a tonic plan, in so far as it tends to supply blood, which is the pabulum of tonicity as well as of other vital properties.

SECTION III.

PROPERTIES OF THE NERVES.—SENSIBILITY.

125. Certain parts of the nervous system being known to be the instruments of sensation, we have no difficulty in tracing diseased sensibility to this system: and as this system consists of a medullary centre, and of nerves converging from various parts to it, so we find that alterations in the property may depend either on disease of the centre, causing disorder of *general sensibility*, or on disease of one or more of the nerves, causing disorder of *local sensibility*. These we shall now notice.

DISEASES OF GENERAL SENSIBILITY.

These may consist in—1, *excess;* 2, *defect;* 3, *perversion.*

126. (1.) *Excessive sensibility* is more or less present when the nervous centres are excited in the early stage of their inflammation or of determination of blood to the head; where there is intolerance of light, noise, and motion. A similar condition exists in hydrophobia and tetanus, from mere excitement, without inflammation. But short of these, sensibility is excessive in some persons, either congenitally, (§ 44,) or as a consequence of disease, (§ 31, 34.) Such persons are commonly called nervous; they are

worried with trifles; startled at shadows; distracted by noise or bustle; never free from some ache or pain; for almost every feeling is suffering; and what in others would be slight pain, in these amounts to agony. Hence they are perpetual invalids, quite unfit for the rugged path of life, over which they, as it were, walk barefooted and thin-skinned. If real disease attack them, its nervous symptoms are so much exaggerated, that a medical attendant is apt to fall into the error of either ascribing all to "the nerves," or of measuring the disease by the severity of the symptoms. This over sensibility is generally conjoined with excess of irritability, and want of tone, (§ 113, 123.) Other nervous functions, such as sympathy and reflex action, are also often augmented or in disorder. The symptoms connected with sensation most frequently present are neuralgic pains of various parts, excessive sensibility of the surface, headache, pain in the back, and spinal tenderness.

127. The pathological cause of increased general sensibility is probably a slighter degree of the same cause which induces it in the early stage of encephalitis, an undue supply of blood to the posterior columns of the spinal marrow, the corpora restiformia, and the parts of the cerebral mass concerned in sensation. This local determination of blood may result from original development; but it may also be a consequence of inflammatory affections of the encephalon, of irregularities in the menstrual functions, or of the reaction ensuing after great losses of blood, all of which are known to be sometimes the precursors of morbid sensibility. On a future occasion, in connection with the subject of irregular distribution of blood, we shall endeavour to point out why great losses of blood and other causes of sudden weakness are sometimes followed by excessive sensibility. The over refinements and luxurious habits of the upper classes, with more excitement for the mind than for the body, and for the feelings than for the understanding, are well calculated to foster morbid sensibility, (§ 69.)

128. *Remedial measures.*—The medicines most in opposition to this element of disease are narcotics or anodynes, such as opium, henbane, hemlock, Indian hemp, &c., administered internally. These diminish nervous sensibility; and in proportion as this is exalted, (§ 126,) the system will bear larger doses. But where the increased sensibility depends on inflammation or vascular excitement of the nervous centres, (§ 127,) the proper treatment will obviously be that to be hereafter described as antiphlogistic. Again: where the excessive sensibility arises from nervous excitement and irregular circulation, with general weakness, (§ 116,) and atony, (§ 123,) (by no means an uncommon combination,) tonics, (§ 124,) and stimulants, (§ 119,) as well as narcotics, are the proper remedies. Weakness and slow transmission of the

arterial pulse, (§ 123,) and absence of flush or heat of skin, are the chief symptoms of such a condition. In these and other common cases of morbid sensibility, country air and exercise, plain food for both mind and body, early hours, and an avoidance of all enervating habits, are often more conducive to the cure than any medicines.

129. (2.) *Defective* general sensibility in its extreme degree is exemplified in coma from the circulation in the sensitive centre of the nervous system being impeded in consequence of pressure, congestion, or other obstruction, (§ 54,) or of narcotic influence. Thus a person in a fit of apoplexy, or poisoned by opium, has lost all feeling, as well as voluntary motion. When the blood becomes impure by retention of excrementitious matter, as in suppression of urine, a like stupor occurs, (§ 70.) Very rarely *anæsthesia* exists—that is, loss of sensation, without loss of motion. But short of these degrees, there are some who congenitally, (§ 44,) from disease, (§ 31, 34,) or from age, (§ 51,) are *deficient* in sensibility—feel less than other folk. All their feelings are obtuse and their actions slow; they have no intense suffering or pleasure. Such persons have also little irritability, but much tone of fibre, and are remarkable for their immunity from many diseases. But they are the more liable to others, such as fulness of blood, apoplexy, gout, costiveness, and the various evils which these may bring. They contrast well with the over-sensitive in this, that disease when it occurs may advance far and become dangerous before it is felt; and may imperceptibly increase until it is past removal, or until sudden death ensues.

130. *Remedial measures.*—When obtuseness of feeling arises from fulness, obstruction or pressure of blood in the nervous centres, the treatment will consist in attempts to remove these by depletion, derivation, and other means to be mentioned under the head of disordered circulation. Where there is no actual disease present, but merely a torpor of the sensitive function, mental excitements and bodily exertion, cold bathing and friction, are the best means of preventing a gradual descent into a state of lethargy. It is doubtful whether we have any medicine capable of directly increasing sensibility. Strong tea and coffee perhaps have the best claim to such a property. What effect would arise from electrifying the spine and occiput? Stupor and impaired sensibility may arise in a state of anæmia, as in cerebral syncope, and in children or females who have lost much blood; this is from stagnation of the blood in the brain. Under such circumstances, the pallor of the skin and weakness of pulse would indicate stimulants as the best means of restoring sensibility.

131. (3.) *Perverted* general sensibility is often manifested by those in whom there is also increased sensibility, (§ 126,) but its character is in the peculiarity of the sensations which are experienced. Thus sensations of tingling, prickly heat, trickling cold, in various parts; feelings of a lump in the throat, a hot ball in the side, a fluttering at the stomach, and illusions of the special senses, may severally and variously affect persons whose sensibility is modified more in kind than in degree. Such persons may also have a depraved appetite, craving for sour things, cinders, mortar, and all manner of filth. These symptoms generally occur in females, often in connection with irregular menstruation, therefore they are called hysterical; but their pathological cause must be sought in the nervous system, the functions of which, probably from irregular supply or bad quality of the blood which supports them become disordered. The *remedial measures* indicated for this condition are therefore those calculated to remove its cause: chalybeates and other tonics, with pure air, nourishing food, and other means which improve the quality, and equalize the distribution of the blood. Narcotics and sedatives may be useful as temporary palliatives. In rare cases, the general sensibility is perverted by structural change in the nervous centres, such as softening of the cerebral structure.

DISEASES OF SENSIBILITY OF PARTS.

132. The feeling of a part may be *excessive*, *defective*, or *perverted*. This may be illustrated by experiment. By irritating or striking a nerve, pain is produced in the part to which it is distributed, and the sensibility of the part remains exalted—that is, it feels tender afterwards. By pressing on the nerve, a new and perverted sensation of tingling and pricking, with numbness, is caused. By pressing more strongly, or dividing the nerve, the feeling is further impaired or altogether destroyed. Similar effects may be produced by a tumour, ligature, effusion, or other cause pressing on a nerve in its course. Disease of the nerve, or of a part of the spinal or cerebral matter connected with it, may likewise modify the sensation of parts. Thus inflammation of the sheath of the ischiadic or trifacial nerves may cause first neuralgic pain, and afterwards numbness in the parts to which the nerve is supplied. There are other painful affections which are to be considered, and treated as cases of exalted sensibility, such as the irritable (as Dr. Billing observes, erroneously so called) breast, testicle, uterus, &c.

133. But the function of sensation, as other functions, depends on the supply of blood to the extreme distribution, as well as to the trunk and origin of the nerves. Hence if blood does not

1 S. appetite.

circulate freely through a limb, the sensations are impaired; and if it passes too freely, the sensibility is exalted, and there may be itching, tenderness, or even pain. In organs of special sensation, the senses are modified, together with the common feeling: thus in disease of the optic nerve or retina, there will be intolerance of light, or specks and clouded vision, or even blindness; in the ear, ringing and beating noises, or deafness, besides the affections of common sensibility, itching, tenderness, and pain.

134. At the orifices of passages into the interior, there are peculiar kinds of sensibility connected with the functions of ingestion and egestion; these modified are elements of disease. As examples of such excessive sensibility, may be enumerated thirst, craving, nausea, tenesmus, and painful micturition: of impaired sensibility, anorexia, and paralysis of the rectum and urethra.

135. When we come to internal parts, we have only to consider their sensibility when *exalted* by disease. We do not know that they naturally possess any feeling. Of the ordinary processes, as of the passage of food and fæces in the alimentary canal, of the movements of the lungs, of the heart, and of the blood through the vessels, we are not conscious; but under the influence of disease we become painfully sensible of several of these motions. This excessive sensibility is developed by inflammation, as in pleurisy, peritonitis, meningitis, &c., or by irritation, by mechanical or other means, as in colic, biliary and urinary calculi, gastralgia, perforation of the stomach or intestines, &c. It is very remarkable that pain from these, which is perhaps severer than any, should arise so suddenly in parts which give no evidence of common feeling.

136. In many instances we are to regard pain merely as a symptom to be removed only by means which remove its cause, the lesion which produces it, (§ 132, 133;) but in many cases, on the other hand, although a symptom, it constitutes a chief element of the disease, and one against which remedies must be expressly directed. Thus it is in neuralgia, gastralgia, nephralgia, colic, dysmenorrhœa, and perforated intestine. So long as the excessive pain lasts, all the functions suffer, (§ 69,) faintness and exhaustion ensue, and if no relief comes, the prostration may be fatal. Here to mitigate or remove the pain is a first and pressing indication. Again: in some other cases where the pain is less severe, it may be very hurtful by interfering with important functions. Thus the stitch of pleurisy impedes the breathing: the pain of tenesmus and the irritation of the stomach or windpipe cause efforts at straining, vomiting, and coughing, so violent, that the functions are thereby kept in a state of disturbance, and the strength is exhausted. Here it may be necessary to treat promptly for the pain on account of its immediately pernicious effects.

137. *Remedial measures.*—Where excessive sensibility depends on inflammation, antiphlogistic measures will generally soon remove it. Where it lingers after the inflammation, is out of proportion to it, or is independent of it, then anodynes become the chief remedy. The most powerful of these are opium and its active principles; but these have morbid effects, (impairing the secretions,) (§ 70,) which sometimes render opiates less eligible than the weaker but safer narcotics, hemlock, henbane, stramonium, belladonna, Indian hemp, and aconite. These different anodynes are used both internally and externally.* Counter-irritation and warmth are also means of relieving pain. The pain of gastrodynia may often be removed by a sinapism to the pit of the stomach—that of colic and dysmenorrhœa by hot fomentations, or bags of hot sand or salt, &c. In other cases, painful feelings may be relieved by such pressure on the part as will counteract tension, and diminish without stopping the flow of blood through the part.

138. We are not possessed of equal means of restoring lost sensibility. Stimulant applications and frictions are serviceable where the defect arises from deficiency of circulation in the part; and strychnia or cantharides given internally, and electricity used topically, *perhaps* may have some little effect in exciting the functions of the nerves, but more doubtfully in regard to sensation than to motion.

SECTION IV.

DISEASED VOLUNTARY MOTION OR EXCITOMOTION BY THE WILL.

139. The function by which certain nerves convey the impulses of the will to voluntary muscles, may become disordered, and its phenomena constitute an element of disease. Some of these have already been noticed under the head of diseased irritability, (§ 113;) and it was there observed that the error is more commonly in the nervous influence which excites the muscles, than in the property of the muscles themselves. This is the case in most convulsive diseases, and in those cases of paralysis which depend on injuries of the voluntary nerves, or of those parts of the spinal and cerebral system which are the channels of volition. A brief illustration of these diseases will suffice to correspond with those of diseased sensation.

* Painful affections occurring with a weak circulation are sometimes removed by tonics: thus neuralgia has been successfully treated with iron, hemicrania with quinine, &c.

DISEASES OF GENERAL VOLUNTARY POWER.

140. Voluntary motion may be said to be *generally in excess* when the brain is excited by strong emotions or feelings, (§ 66,) by stimulating liquors, (§ 55,) and by the hurried circulation of phrenzy or phrenitic delirium. Hysteria, as usual, can supply like examples. The strength and rapidity of movements displayed in hysterical cases are sometimes astonishing: yet they are obviously voluntary movements, for they are often performed rhythmically, or to a time, as in dancing. The dancing of tarantulism, and the extravagant exertions of the fanatics called jumpers, would seem to arise from an erethism of the part of the nervous system concerned in voluntary motion. Short of disease, a naturally high voluntary power is evinced in the energetic and active movements of some persons, who excel and delight in feats of strength or agility. Mere muscular strength will not suffice without nervous energy to act on it.

141. *General volition* is more or less *defective* in apoplectic coma, stupor from various causes, pressure, congestion, narcotism, &c., where other nervous properties are also impaired, (§ 129;) in trance, catalepsy, and nightmare; in a less degree also in cases of lethargy and weakness from over-exertion, (§ 68.) This defect may be sometimes suddenly induced by terror, surprise, &c., (§ 69,) which for a time take away the power of motion. Hence the fabulous power of the Gorgon's head; and the signification of the expressions *petrified with astonishment*, *motionless with terror*, *fascinated*, and the like. The muscular power (§ 110) is not lost in these cases, but only the influence of the mind over it—that is, volition.

142. Examples of *perverted voluntary power* may be found in chorea, delirium tremens, and some analogous affections called hysterical. In these volition may be often also defective, (§ 141,) but it is not always so; only each act of the will is perverted in its performance. The will sets muscles in motion, but the wrong muscles, or too many, too forcibly, or irregularly, so that the resulting action is not in accordance with the will.

PARTIALLY DISEASED VOLUNTARY POWER.

143. We can scarcely point out examples of partial *excess* of *voluntary* motion. The convulsive movements of voluntary muscles are quite involuntary, and have been noticed under the head of diseased muscular action, (§ 113;) but it was there mentioned that they may arise from irritation of the nerves, independent of the will. Hysteria does, however, furnish examples

of excessive movements of one limb or part of the body, so far amenable to mental influence as to be excited and timed by ideas in the patient's mind. These cannot be said to be wholly involuntary; but are the result of a wilful impulse, perhaps too strong to be *easily* resisted.

144. *Partial defect* of voluntary power is very common, and, like local defect of sensibility, may be traced to partial disease of the motor (anterior) columns of the medulla and prolongations; or to disease of, or pressure on, a motor nerve in its course; or to a disordered condition of the ultimate distribution of the nerve, or of the circulation supporting its function. Thus paralysis of voluntary motion in an extremity or a whole side, (hemiplegia,) may arise from disease in the optic thalamus or corpus striatum of the opposite side: these being the channels of communication between the cortical seat of the sensorial functions and will, and the motory columns and nerves. Lesions of the motory (anterior) columns within the spine may intercept more or less the voluntary power over those parts supplied with spinal nerves from below the diseased point. Thus a lesion in the lower cervical portion may paralyze the upper and lower extremities and whole trunk, (except the diaphragm, which is supplied by the phrenic nerve:) a lesion in the dorsal or lumbar portion paralyzes only the lower half of the body, (paraplegia,) or lower extremities. Or the disease may be more partial, paralyzing one nerve only, as the portio dura, causing distortion of the features; or the ninth nerve, causing difficult articulation, &c. The lesion of the nervous textures here alluded to may be structural change, as tumours, effusions, or hæmorrhage, or only an altered state of the blood-vessels of the part. Severe cold or continued pressure will impair voluntary power in a limb, by checking the free flow of blood, which is essential to the proper function of the nerves as well as of the muscles. Hysteria affords numerous examples of volition impaired in parts, as in loss of voice and power of articulation, retention of urine, paralysis of limbs, &c.: these affections may come on quite suddenly, and as suddenly cease.

145. *Remedial measures.*—*Excessive* voluntary power is rarely an element of disease for separate treatment. As part of the excitement of the nervous centres, it may be reduced by sedatives of different kinds—depletion, antimonials, and cold to the head, being the most effectual where the excitement is attended with determination of blood; morphia, and other narcotics, where the excitement is more purely nervous. The violent exertions of maniacs are wonderfully controlled by the cold douche to the head, sometimes with nauseating doses of tartar emetic.

146. The treatment of *defective* volition will consist in means calculated to excite the nervous centres directly, or through the medium of the circulation. Agents which restore free circulation of healthy blood through the nervous centres and branches generally improve voluntary power. Thus a stimulant draught may raise the failing strength of a person fainting. By warmth and friction, one who is benumbed with cold recovers the use of his limbs. Sleep or rest will restore voluntary power exhausted by fatigue. Sudden and powerful mental excitement, as by a fright, has been known to restore voluntary power which had been long lost. A lady who for several years had lost the use of her lower extremities, was startled by a rat running near her: having an extreme antipathy to the animal, she made an effort, and sprang on a table near; the power, however, did not remain, for she could not get down again. A more permanent cure of impaired volition has been effected by the excitement of religious fanaticism, as in the cases of the supposed miracles of Prince Hohenloe, Miss Fancourt, &c. As we have found that such mental excitement sometimes causes excessive voluntary motion in healthy persons, (§ 140,) so we perceive that, suddenly applied, it may restore it where defective.

But sometimes volition is defective from pressure on, or congestion in, the brain, which prevents the due motion of the blood through it, as in plethoric lethargy, or apoplectic coma: here depletion and derivation may sometimes restore the power. In the lethargy of narcotism and asphyxia, the volition is often restored by means which excite strong sensations and reflex actions, as dashing cold water on the face and chest, ammonia or other stimulating vapours to the nostrils, electric shocks, stinging with nettles, &c. The trance or coma of hysteria may often be removed by a turpentine injection, or croton oil purgative, which acts both as a revulsive to the vessels and a stimulant to the nerves.

Perverted volition will require various treatment according to its kind; that of delirium tremens being corrected by narcotics, especially opium; that of chorea, by nervous tonics, especially iron and zinc.

147. The treatment of *locally diseased* voluntary power will generally commence with attempts to remove its cause, which we have found to vary too much both in seat and nature to admit of an elementary statement of remedial measures. Those for defective voluntary power comprehend the complex subject of the treatment of paralysis, which commonly comprises means calculated to restore to its proper state the circulation through the affected part of the nervous system, and sometimes, also,

and end in a failure to effect that purpose.

means which stimulate this part by exciting agents, such as electricity, stimulating frictions, and blisters; and strychnia and cantharides given internally, which are supposed to have a directly stimulant action on the motory columns and nerves.

SECTION V.

DISEASES OF REFLECTED AND SYMPATHETIC NERVOUS INFLUENCE.

148. The nervous property by which various movements and processes connected with organic life are excited, may be disordered, and its alterations are remarkable constituents of many diseases. The contractions of all the sphincters, of the œsophagus, the glottis, the iris, the eyelid, and the regular action of the muscles of respiration, seem to be sustained, independently of the will, by a nervous influence conveyed by afferent nerves from the respective parts or surfaces to the spinal marrow, and reflected from it through the efferent nerves to the muscles connected with these parts. The full establishment of this physiological principle we owe to Dr. Marshall Hall.

149. The *increase of this involuntary excitomotory* power is instanced in the spasm of the throat, and sometimes of the sphincters, in hydrophobia, tetanus, and some hysterical affections. The hurried respiration, the convulsive cough, violent retching, and hiccup, which are occasionally presented in these and other nervous diseases, may also be in part traced to an undue influence of the excitomotory nerves of organic life. These actions are sometimes excited by sensations, (§ 134,) as the breathing by feeling of want of breath, cough by tickling in the air-passages, retching by nausea, &c.; but it is where either there are no such sensations, or where they bear no proportion to the violence of the actions, that we are warranted to conclude that the excitomotory function is itself exalted.

A similar exaltation of the excitomotory function, independent of sensation and volition, is exemplified in the voluntary muscles, when they are deprived of sensation and voluntary motion by disease in the brain itself, or cutting off communication between the brain and spinal cord, without materially injuring the cord itself, (§ 118.) Thus, in paraplegia from injury of the upper part of the spine, the excitomotory power of the nerves of the lower extremities is exalted, and tickling, or mere touching the soles of the feet or legs, will produce convulsive motions, although all voluntary power and sensation be wholly lost.* This phenomenon is sometimes so readily produced as to be a cause of much disturbance to the patient, the mere touch of the bedclothes exciting troublesome startings. The same thing occurs in hemiplegia, but less distinctly, as the cerebral influence is rarely here so completely intercepted. I have known, however, the convulsive motions of a paralyzed limb so violent, in a hemiplegic patient, that it was necessary every night to fasten it down to the bedstead to enable the patient to get sleep.

Another instance of involuntary excitement of the muscles occurs in the symptom of "fidgets," which often arises from irritation reflected from the lower part of the intestinal canal, or from the uterus.

150. Under this head we must also glance at convulsions, which, according to Dr. M. Hall's views, and consistently with the phenomena of disease, must be referred to an irritation of the true spinal system. This irritation may be *centric*, as in epileptic and apoplectic convulsions from disease in the head, and those from loss of blood; in which cases, the spinal and prolonged medulla being excited, the excitomotory influence radiates to the limbs and muscles generally; or it may be *eccentric*, commencing with irritation of the extremities of some efferent nerve, which transfers it to the spinal centre, whence it is again reflected generally or partially. Such are the convulsions arising from teething, uterine, intestinal, and renal irritation; and a slighter degree is exemplified in the rigour caused by the sudden impression of cold on the surface, or by passing a bougie into the urethra of a nervous person.

151. *Partial spasms* caused by *reflected irritation* are exemplified in cramp in the legs, from acrid matter in the colon, in diarrhœa and cholera; retraction of the testicle from calculus or inflammation of the kidney; spasm of the glottis from a bone sticking in the pharynx, &c. More familiar examples of the same class of reflected irritation are found in sneezing from irritation of the nares, winking from irritation of the conjunctiva, coughing from irritation of the glottis, retching from irritation of the fauces, efforts to evacuate the rectum and the bladder from irritation of these parts respectively. But it must not be forgotten that all these latter examples are connected with obvious

* The same phenomenon is exhibited in a high degree in the decapitated frog, in which touching the surface excites convulsive movements. A still more interesting illustration sometimes occurs in animals or persons whose cerebral power (sensation and voluntary motion) is impaired by opium or other narcotics; spasms or convulsive actions of the muscles being induced by tickling or pinching the skin, which shows the excited state of the reflex or spinal function.

sensations; and they imply increased excitomotory influence only in those cases in which they are out of proportion to these sensations.

152. But some of the most remarkable instances of reflected irritation are displayed in the involuntary muscles, the heart, and the muscular fibres of the air-tubes and intestinal canal. Thus inordinate action of the heart (palpitation) is commonly caused by irritating matters in the stomach or intestines, kidneys, or other viscera, (§ 51, 54;) nay, we shall afterwards find, that the heart is liable to be excited by considerable irritation in any part of the body, as in fever and constitutional disorder. The spasm of the intestines in colic is induced by reflex irritation resulting from acrid matter in them; for if it were from direct irritation alone, the spasm would only affect the part touched by the offending matter.* The spasm of the bronchi, so suddenly occurring in spasmodic asthma, also sometimes arises from intestinal irritation. It has long been supposed, and is still a common opinion, that these morbid sympathetic movements are due to the direct nervous connection which the great sympathetic nerve establishes between the respective organs; but this supposition assumes, what experiment has not proved, that the ganglia of this nerve are either centres of reflection,† or sources of nervous influence, which is still more inconsistent with the latest researches. So far as we yet know, the spinal marrow is the centre of reflection in these as in all other examples of reflex action which we have been considering, although the sympathetic be the medium of communication.‡

153. When phenomena of inordinate reflex actions are general or extensive, as in convulsions, tetanus, and paraplegia, we must refer them to an undue excitement or erethism of the spinal and prolonged medulla; but the more partial examples may arise from similar excitement of a small portion of it only, or of the incident (afferent) nerve of the part which occasions the phenomenon, or of the excitomotory (efferent) nerve of the part which exhibits the phenomenon.

If we seek to know the causes of this excitement, we shall find that, as in excess of other vital properties, it is sometimes referable to an increased flow of blood through the spinal marrow or its nerves, or the branches of the sympathetic nerve. Thus the early stage of inflammation of the spinal cord, or of its sheath, is attended with convulsions or tetanic spasm. It is very probable, that the spinal excitement (convulsions) occurring in epilepsy and apoplexy, is in part due to the flow through the medulla

* Müller's Physiology (by Baly), p. 737. † Volkman, Müller, p. 738.
‡ Valentin, Carpenter's Human Physiology, Am. Ed. p. 150.

being increased in proportion as that through the brain is impeded: a consideration of the causes of convulsive paroxysms, and of the distribution of the vertebral arteries, much countenances this supposition. But in many cases the excitement seems to be of a more direct nature. Strychnia in a poisonous dose excites the medulla so speedily, causing tetanic spasm, that its effect can scarcely be due to increased flow of blood. So, too, we know, that mechanical irritation of the spinal marrow or of its nerves will cause convulsive motions; and we find this exemplified in the effect of tumours and spicula of bone in the spinal canal, in the head, or in the course of nerves. But nothing exhibits this element of nervous irritation (apart, so far as is yet known, from vascular influence) so fearfully as traumatic tetanus. The irritation here begins in a distant nervous branch, and is propagated to the medullary centre, the excitomotory function of which at length exhibits a state of erethism, which destroys life either directly by tonic spasm (§ 114) of the muscles of respiration, or by exhaustion. Another cause, which may be fairly assigned for increase of the involuntary excitomotory property, is accumulation by rest. This causes the augmentation of this property in the medulla in narcotism, and in injuries of the spine, (§ 149,) which suspend the exhausting influence of volition on the whole or part of the marrow, in which the nervous energy therefore accumulates, and becomes unusually abundant. There can be little doubt that sedentary habits, and too much indulgence of sleep, likewise may cause an accumulation and morbid excess of nervous power, and develop convulsive and spasmodic symptoms, which are the result of its overflow.

154. *Defect* of the reflex, or involuntary excitomotory function, is exemplified in the paralysis which affects the sphincters, the eyelids, the muscles of respiration, and others whose normal action depends on this function, (§ 148.) When this is generally and considerably impaired, the result will be fatal, because the respiration, deglutition, and other actions essential to life, suffer. It is by affecting these actions that apoplectic coma and narcotism prove fatal; and the state of sinking from excessive weakness or depressing causes, also exhibits the failure of the reflex power, when the urine and fæces are voided involuntarily, and the breathing is irregular and gasping, being forced by voluntary effort. From failure of the same power, coughing and expectoration become inefficient in clearing the air-passages of mucus; hence the bronchial and tracheal rattles which precede death. As these movements are the last to fail, so in recovery from asphyxia, syncope, and other similar states of partially suspended animation, the actions connected with the reflex function are the

first to return with the restoration of life; and thus vomiting, coughing, and sneezing, are among the early signs of reaction.

155. *Remedial measures.*—As with other instances of exalted nervous function, so with *excessive reflex action,* when dependent on inflammation, or determination, or congestion of blood in the medulla, the remedies for these are appropriate against this effect: and the same measures in smaller degrees are often useful in hysterical affections when these occur with fulness of habit, and spinal tenderness. In case of irritation of the nervous centres, more purely nervous, as that of tetanus, hydrophobia, poisoning with strychnia, &c., a narcotic or sedative, which may lower the exalted function, is the desideratum. We possess some agents which powerfully reduce the power of the spinal system, and cause general relaxation of the muscles, such as hydrocyanic acid, woorara, Indian hemp resin, and conium: these drugs may themselves destroy life, by arresting the function of the medulla oblongata in maintaining respiration; but this very poisonous action, and the sedative effect which one (hydrocyanic acid) also has on the heart, render the remedy almost as dangerous as the disease.* For slighter irritation of the medulla, however, these medicines in moderate doses, and a few others like them, are often beneficial. Thus hydrocyanic acid is a very efficacious remedy in vomiting, nervous palpitation, and hiccup; it is also useful in convulsive cough, in which, however, the extracts of belladonna and stramonium are still more effectual, as they also are in spasmodic asthma. The same medicines and opium are often beneficial in relieving the spasms of colic, dysentery, and dysuria.

Some medicines, which act as stimulants to the heart and vessels, and to the cerebral functions, seem to operate as sedatives to the medullary system: these are the stimulant antispasmodics, such as æther, ammonia, musk, essential oils, gum—resins, creosote, alcohol, &c., which are useful remedies in spasmodic and convulsive affections in weak subjects, without inflammation; they probably operate by giving vigour and equality to the circulation. External heat and counter-irritation act in a similar way.

There is another class of remedies which have some power in reducing the excitability of the spinal excitomotory system—namely, tonics, especially those prepared from metals; but the operation of these is gradual, and therefore probably indirect. The sesquioxide and other preparations of iron are efficacious in

* From the late accounts of Dr. O'Shaughnessy and others, the resin of the Indian hemp seems to be more powerful than any other remedy in relaxing tetanic spasm, and in at least alleviating the symptoms of hydrophobia.

chorea, and perhaps in the more chronic forms of tetanus. Nitrate of silver, sulphate and oxyde of zinc, and sulphate of copper, have been found to diminish the attacks of epilepsy, hysterical convulsions, spasmodic asthma, and cough, and other convulsive affections. The more obvious operation of these remedies is on the vascular system, to which they prove astringent and tonic, and it is uncertain whether their beneficial action in nervous diseases is of this kind only, equalizing the circulation, or whether they exercise any more direct influence on the nervous system. The same question is open with regard to certain regiminal means of reducing nervous excitability, such as cold bathing, country air, and change of air, and exercise. The latter, however, no doubt, may be useful by exhausting the superfluous nervous power (§ 153) by another channel, voluntary motion.

REFLECTED OR SYMPATHETIC SENSATIONS.

156. Clinical observation teaches us that not merely motory impressions, but those also which cause sensations, may be reflected, so that when the impression is made on one part, the sensation is experienced in another. I do not allude to the fact that a stroke on the nervous trunk produces feelings referred to its branches, but I advert to impressions on the ultimate distribution of one nerve producing sensations in parts supplied by another nerve, or by another branch of the same nerve. The following are examples of this kind. Touching the external auditory meatus causes a tickling sensation in the glottis. A calculus in the bladder produces pain referred to the extremity of the penis. Ascarides in the rectum cause itching of the anus, and sometimes of the pudenda. Congestion of the liver sometimes is accompanied by pain in the right shoulder-blade; and a disordered state of the stomach, occasionally with pain in the left shoulder-blade. The pains of angina and gastrodynia often extend to the whole chest, and the former especially radiates to the left arm. Severe frontal headache is almost instantly caused in some persons by acid ingesta, in others by eating ice. Irritation of the intestines, as in cholera and colic, (especially painter's colic,) frequently causes pain and tenderness in the legs and feet, even when there has been no cramp or other excitomotory phenomena. Temporary neuralgic affections seem to be due to similar causes.

In these and other instances that might be cited, the sensations cannot be referred to direct nervous communication, but to an influence reflected, probably from the spinal centre only.

The sympathies subsisting between some organs are very remarkable, and none more so than between the breasts and the

+ The spermatic fluid has never been found in the blood. It would appear also from the experiments of Claude Bernard that the different organs possess a formative as well as secerning power. Sugar he demonstrates, to be formed in the liver & destroyed in the lungs.

uterus. Applying the infant to the breast often induces uterine pains in women recently delivered; and the catamenial discharge has been excited in some instances by stimulating applications to the breast.

157. The *remedies* most effectual in relieving reflected sensations are—1st, those that remove their irritating cause; and 2d, those that deaden sensibility, (§ 137,) anodynes. The peculiar efficacy of trisnitrate of bismuth and hydrocyanic acid in relieving gastrodynia and some kinds of angina, is, however, not explicable by any narcotic quality.

SECTION VI.

DISEASES OF SECRETION.

158. The power of secretion appears to be a vital endowment of the ultimate cells or molecules of secreting structures.* It is uncertain whether the process comprises the formation as well as the separation from the blood of the peculiar matter of the secretion. In the case of the urine and bile, it would seem that they may be formed in the blood without the aid of the secreting organs; for urea is found in the blood of animals whose kidneys have been prevented from acting by ligature of their blood-vessels, or by extirpation; and both urea and some of the principles of the bile (colouring matter and cholesterine) are found in the blood and in various parts of the body when the kidneys and the liver respectively have been disabled by disease. But whether the secreting structures assist in the formation, or only affect the separation, of the matters which they eliminate, their elective power is equally a peculiar attribute of life, and is at present inexplicable by any physical or chemical law. I have for the last twenty years† advocated the opinion recently advanced by Dumas and Liebig, that the formation of the principles of the chief secretions takes place through chemical affinities, especially those of the absorbed oxygen and the constituents of the blood, controlled by vital agencies; but this view leaves still as a vital property the power which the liver has to separate bile; the kidneys, urine; mucous membranes, mucus, &c.

We are thus led to consider secretion as a peculiar property of the secernent structures, just as irritability is of muscular fibre,

* Müller De Glandularum penitiori structurâ. Henle, Allegemeine Anatomie. Goodsir, Trans. Royal Society of Edinburgh, 1842. Bowman, Phil. Trans. 1842.

† In a thesis, *De sanguine ejusque mutationibus*, Edin. 1824. See also Med. Gaz. September and October, 1835

(§ 110;) and as such its disorder constitutes a primary element of disease. In doing this we avoid the hypothesis of some physiologists, who ascribe secretion to nervous influence, a notion by no means accordant with numerous facts.

159. In reviewing the disorders of other vital properties, we have found that many of them are plainly referable to changes in the supply of blood to their respective textures, (§ 113, 127, 131, 133, &c.) The same cause may be found still more decidedly to operate in producing variations in the process of secretion. The blood being the material from which the secreted matter is supplied, variations in the quantity or quality of the blood will surely alter the quantity or quality of this product. Thus when an increased flow of blood takes place to a mucous membrane, its secretion is increased, and sometimes rendered more acrid than usual; whilst a congested state of the same membrane or of the liver may impair the secretion. Hence the most common causes of altered secretion are those which operate on the sanguiferous system and its contents.

160. But affections of the nervous system, and of the mind, which acts through that system, may also affect the secreting process, as shown by the mouth watering at the sight or thought of a good meal; the bilious diarrhœa that mental agitation will cause in some persons; the large flow of limpid urine after nervous excitement; the tears excited by grief or other strong emotion; the unwholesome quality of a nurse's milk when she is in a state of anxiety or apprehension. We do not know whether these influences act by altering the flow of blood, (§ 159,) or by more directly modifying the vital property of the secreting organ, (§ 158.)

161. The importance of this element of disease may be estimated, from the ubiquity of the process of secretion, which includes both *excrementitious* (only to be voided out of the system) and *recrementitious* products, (those concerned in digestion, assimilation, and nutrition,) and also from the extent of its effects in relation both to the destination of the secretion, and to the blood from which it is separated. These may severally be EXCESSIVE, DEFECTIVE, and PERVERTED.

162. EXCESSIVE SECRETION of any kind, whether bile, urine, mucus, &c., may weaken by the drain which it causes from the mass of blood, (§ 28, 71;) and this effect will be in proportion to its quantity, and especially to the animal matter which it contains. Thus an excessive secretion of bile weakens more than that of thin mucus. But each secretion may have peculiar effects connected with its office and composition; and these effects may be *forwards*, on the parts to which the secretion goes, and *backwards*, on the organ and the blood from which it is formed.

163. The *forward* effects of an excessive secretion of bile depend on its stimulating properties. It irritates the intestinal tube, causing a bilious diarrhœa or cholera. The symptoms of this consist in an exaggeration of those properties of the alimentary canal which have already been described as elements of disease. Thus the bile irritating causes increased irritability, (§ 113,) and more rapid motion of the matter through the tube; pain from exalted sensibility, (§ 134, 135;) vomiting, straining, and cramps, from exalted excitomotory function, (§ 149, 151;) profuse mucous secretion from excited secernent function, (§ 162.) An excessive secretion of mucus in the intestines may cause only simple diarrhœa; but in the bronchi it may occasion dyspnœa and cough, and, if not expectorated, may suffocate. Excessive secretion in the stomach may cause pyrosis or waterbrash, the liquid being sometimes acrid, and occasions nausea and vomiting as well as eructation. The excessive secretions of secreting organs generally may amount to a flux or profluvium; and those from internal enclosed serous surfaces or cellular texture constitute various dropsies. These produce different effects according to their situation.

164. But excessive secretion may also have effects *backwards*, on the *organs*, and on the *blood* from which it proceeds. Excessive secretion often weakens the vital properties of the *organ*, so that, in its proper function, it subsequently becomes torpid. Thus after diarrhœa the bowels often become torpid from defective secretion. So, too, in cases where an excessive secretion continues for a long time, it generally is impaired in its quality from a similar cause.

165. Excessive secretions, if abounding in animal matter, may not only reduce the mass of the blood, but also affect its composition. Thus bile and urine, which differ much in composition from the blood, if separated in unusual proportions, must leave the blood modified. Urine contains a great preponderance of azote; and its excessive formation from the principles of the blood would leave a predominance of hydrogen and carbon in this fluid. The bile, again, abounds in hydrocarbon; the copious removal of which would leave a superfluity of azote. It may be objected to this statement, that, according to the opinion of some chemists, the urine and the bile are not formed from the constant elements of the blood, but from materials derived from the food, and from the decay or transformation of the tissues. To this it may be replied, that this opinion is at present no more than hypothetical; and should it prove to be true, it would not affect the undoubted fact, that the secretions of the liver and of the kidneys are intended to balance one another, and the removal of carbon from the lungs; and that whether the materials from

which these eliminating processes are supplied be the principles of the blood itself, or the decayed constituents of tissues, or matters derived from the food, the co-operation of all these processes will be generally required to maintain a uniformity in the composition of the circulating fluid; so, too, if one of these processes is more active than the others, the blood must suffer by the excess of those matters which the less active processes allow to accumulate in it, (§ 70, 71.) A clinical illustration of this position may be found in cases of bilious diarrhœa or cholera. This flux of bile is either accompanied by a highly loaded state of the urine, or by fever; in the latter case, the fever does not subside until the urine becomes very copious, or deposits an abundant sediment. The most probable interpretation of this fact is, that the excessive secretion of bile disorders the composition of the blood; so long as the kidneys rectify this disorder by separating in greater abundance the solid contents of the urine, no fever results, but if the kidneys fail in this task, fever ensues, and continues until they accomplish it; then a free secretion and copious deposit is symptomatic of the decline of the fever.

166. The *remedial measures* that are serviceable in cases of excessive secretion will illustrate the view that has just been given of the balancing office which the secretions all fulfil. In so far as excessive secretion is dependent on the quantity and quality of the blood, (§ 159,) the treatment should be addressed to this element; by depletion, derivation, and evacuation, in cases of congestion or determination of blood; and in such cases the excessive secretion should not be hastily checked, as it may be a natural means of relief; nay, in some cases, it may be most speedily arrested by means which for the time increase it: thus a large dose of calomel will sometimes, after first purging, stop a bilious diarrhœa connected with an engorged liver, which astringents fail to check. But where the excessive secretion proceeds more from nervous and other sources of irritation, (§ 160,) and causes weakness and disturbance of the functions, it becomes a more immediate indication to check it. Secretions are to be diminished by means which act as general tonics or astringents, (§ 124,) and by others which operate only on particular organs. Of the former class are cold applied to the part, and common astringents, such as alum, superacetate of lead, sulphates of zinc and copper, gallic acid and tannin, and substances which contain them, as nutgalls, oak bark, rhatany root, catechu, &c., mineral acids, &c. These act most surely by direct application, as in their use for diarrhœa, leucorrhœa, &c.; but they seem to have some effect also through the medium of the circulation, as when taken internally they reduce the secretion in the air-passages and skin. Of

the agents which, without a general astringent effect, more specifically diminish the secretion of particular organs, may be mentioned opium, which remarkably lessens the secretion of the liver, and sometimes that of the kidneys.

If an excessive secretion have already caused febrile disturbance, great advantage will be found to result from the use of means which increase other secretions, and thus restore the balance before explained, (§ 165.) Thus in bilious cholera, saline diuretics and diaphoretics are highly serviceable. In renal irritation with copious secretion of lithic acid, blue pill, which augments the secretion of bile, is often beneficial. These means may be supposed to operate partly as derivants; but the manner in which they remove the febrile irritation, after the reduction of the excessive secretion, renders it most probable that they act also by removing from the blood dregs left by the inordinate separation of the matter of the single secretion which has been in excess, (§ 165.) No practical physician can doubt that we possess medicines which often augment the secretions of particular organs, (mercury that of the liver and salivary glands, colchicum that of the kidneys, &c.) yet there is a limit to the operation of these agents; but this limit may be increased by simultaneously acting on other organs which maintain the balance. Thus in any disturbance of the secretions, especially if it continue long, combinations of medicines are much more useful than those fulfilling one indication only; and thus experience has sanctioned the practice of conjoining mercurials with diuretics, and antimonials with salines, &c.

167. Defective secretion of any natural or habitual discharge (§ 70) may cause a fulness of the blood-vessels; a general fulness if the secretion be naturally copious; a local fulness if it be trifling in quantity. Thus defective secretion of urine or bile may cause general plethora, or extensive local congestions, which may end in dropsical effusions, fluxes, hæmorrhages, or inflammations. Diminished secretion of tears or saliva would merely cause fulness and dryness of the parts immediately concerned.

The morbid effects of defective secretion may be both *forwards*, on the parts for which the secretion is intended, and *backwards*, on the organ and on the blood from which it should be eliminated, (§ 162.)

168. Defective secretion of bile causes disorder in the latter stages of digestion. The neutralization of the acid in the chyme and the separation of the chyle, to which the bile seems to contribute, are imperfectly performed: sometimes colic and diarrhœa, sometimes costiveness, results from the defect. Deficient secretion of mucus in the intestinal canal and bladder would expose

their membranes to more irritation from their contents. Probably deficient secretion of mucus on the respiratory membrane may lessen the facility with which the air and the blood act on each other. Insufficient secretion of cerumen in the ear, or of saliva in the mouth, impair respectively the hearing and the process of mastication. A want of synovia in the joints has been supposed to be a cause of their imperfect motion and subsequent inflammation.

169. The effect of defective secretion in causing congestion of its respective organ, has been already noticed: the concomitance of congestion with defective secretion, in the case of the liver, the kidneys, and mucous membranes, is well known; but either may be viewed in the light of both cause and effect.

170. The most remarkable of the *backward* effects of defective secretion are instanced in case of the secretions, (§ 70.) The distinctive materials of the secretions of urine and bile appear to be positively noxious, and poison the system if not separated from the blood. Thus the sudden suppression of urine or bile causes typhoid symptoms, extreme depression, and coma, which speedily end in death; and in such cases, urea, or the colouring matter of the bile, has been found in various organs. Where the suppression is incomplete, the poisoning process is more tardy: various functional and visceral derangements are produced, such as delirium or lethargy, dyspnœa, palpitation, vomiting, diarrhœa, dropsical effusions, structural degenerations, &c., which always prove fatal, sooner or later, if the defective excretion be not restored. In these gradual cases, still more remarkably than in those of more sudden suppression, some of the excrementitious matters may be detected in the blood and in other fluids and solids of the body. Thus in some structural diseases of the liver, the colour of the bile becomes manifest first in a yellow, and by accumulating, in a deep greenish colour in all the textures, constituting the yellow and the black jaundice. In granular degeneration of the kidneys, in which scarcely any urea is excreted by these glands, this principle is found in the blood and various fluids of the body.*

171. The excretions are defective in many idiopathic and symptomatic fevers; and there can be little doubt that many of the constitutional effects of these fevers are in great measure due to this important element. The positively noxious properties which excrementitious matter retained in the blood is known to possess, (§ 170,) must be taken into account when we attempt to explain

* In the case of a patient of mine affected with ascites from disease of the heart, liver, and kidneys, Mr. Garrod obtained nearly four grains of nitrate of urea from an ounce of the peritoneal fluid, and a considerable quantity of bright yellow solid matter, probably bilious.

the states of constitutional irritation and depression, with perversion of functions, which fevers so generally present. The changes in the blood, manifest in some such cases by its fluidity and by petechial appearances, may also be in part referred to defective elimination of effete matter;* and it is when the secreting organs recover their power, and a diarrhœa occurs, or a copious discharge of highly loaded urine, that these appearances cease. It is a question how far severe mechanical injuries or shocks, (§ 52,) and animal and other poisons, (§ 105, 57, &c.,) may operate by thus injuring the vital powers by which the blood is continually purified from its own noxious products; but that this is a part of their mode of action seems almost certain from their effect in suppressing or impairing the natural excretions.

There can be little doubt that a morbid element, which in its extremes acts so injuriously as to cause serious disorder, and even speedy death, must in slighter degrees be an important cause and constituent of disease; and I believe that gout, rheumatism, and many cachectic states leading to diseases of nutrition, degenerations, dropsies, &c., are essentially connected with defective excretion.

172. *Remedial measures.*—Defective secretion may be caused by deficient or excessive supply of blood to the part, as in various cases of anæmia, congestion, and inflammation, (§ 159.) In such cases it must be treated by the proper remedies for these conditions: thus stimulants may restore secretions scanty through a defective supply of blood; and depletion and derivatives may be the best remedies, when they are stopped by inflammation or congestion.

173. But sometimes the first disorder is in the secreting structure itself, (§ 158,) and may best be removed by agents which specifically increase the secretion, which common stimulants will not do. Thus mercury increases the secretion of the liver; colchicum, nitre, and other diuretics, that of the kidneys; croton oil, jalap, sulphate of magnesia, and other purgatives, that of the intestines; and this they do, however introduced into the system, whether by the mouth, through the skin, or injected into vessels or textures. These are important practical facts, however difficult they may be to explain; and their application to restore defective secretions is abundantly obvious.

174. But these specific stimuli of the secreting organs, (§ 173,) if used in excess, or too long, may not only cause general weakness, but also exhaust the vital properties which they excite,

* Purpura I have found to be often connected with hepatic congestion, and imperfect excretion of bile, and to be most effectually removed by remedies which promote the restoration of the proper secretion.

(§ 159;) and the result may be a diminution either of the secreted fluid, or of its most characteristic constituents. Hence the long or excessive use of mercury causes torpidity of the liver; that of purgatives, imperfect action of the bowels; that of diuretics, scanty urine, or albuminous or watery urine, defective in urea. These facts point out the expediency of alternating or conjoining these different agents with others calculated to improve the vital properties of the textures generally, which may often be affected by the medicines called tonic, and by regiminal means which improve and equalize the state of the circulation, (§ 124,) and preserve the digestive and assimilative functions in the best order. In illustration of this position, I may refer to the acknowledged advantage of giving bitters with or after mercurial courses; chalybeates with or after saline aperients and diuretics, when these are long used; and these additions, which alone, or used at first, would check the secretion to be increased, now sustain it and render it permanent. Some medicines which are inferior in efficacy to those already named, are yet, in some instances, more eligible for chronic cases of defective secretion; because they are less exhausting, and combine some measure of tonic influence with that of increasing the secretions. As examples of this kind may be named taraxacum, preparations of iodine, sarsaparilla, nitric and nitro-muriatic acids. Courses of these medicines are sometimes of great efficacy in keeping free the secretions after they have been restored by more powerful means, (§ 173;) and they likewise often improve the functions of digestion and nutrition.

175. Where defective secretions are not readily restored, the *forward* disorder (§ 168) arising from their deficiency may be sometimes remedied by artificial substitutes. Thus, in defective secretion of bile, the action of the intestines has been promoted by exhibiting ox gall. Aloes and soap combined have been thought to supply the place of bile in some cases. Toasted bacon at breakfast has been supposed to have a similar effect; but it more probably excites the liver to increased secretion, as other fat matters do.

Imperfect lubrication of the throat and larynx, and other mucous membranes, from defect of mucus, may be remedied by mucilaginous and demulcent matters. A dry state of the skin may be relieved by applications of oil or honey.

176. Perversion of secretion often accompanies excess and defect of this process. In febrile diseases, the secretions of the kidneys and alimentary canal are altered as well as diminished. Inflammation and determination of blood change as well as increase the secretion from mucous membranes, rendering it more saline, and sometimes albuminous. The urine exhibits remark-

able changes in quality: full living, stimulating beverages, and irritations of the digestive organs or kidneys, rendering it unusually strong and acid; whilst low diet, great fatigue of body or mind, and chronic inflammation of the kidneys, generally make it pale and alkaline. Out of these morbid conditions may arise various further decompositions, with sediments and calculous concretions of different kinds, (§ 51, 53.) Concretions are likewise formed from an altered state of the bile. The perspiration is also sometimes changed; thus it is very acid in rheumatism, and fœtid in delirium tremens.

177. Secretions which serve particular purposes, when altered may become unfit for these, and thus cause disorder: thus a thin acrid mucus irritates instead of protecting the membrane which secretes it, as in coryza and mucous diarrhœa; a viscid dry mucus clogs up and obstructs tubes which it was intended to lubricate; altered gastric juice causes indigestion; sebaceous matter of the skin may accumulate in its follicles, and cause irritation and inflammation, &c.

178. The *remedies* for perverted secretions (§ 176) are usually those which likewise increase secretion, (§ 172, 173.) Thus depraved secretions of the intestinal canal are often satisfactorily altered by continued purging; a turbid state of the urine is sometimes removed by diuretics; too thick a state of the mucus of the air-passages is modified by expectorants, &c. But where the change depends on altered circulation in the part, the remedies must be suited accordingly. In some cases, tonics restore a healthy state of secretions; and in most instances of long-continued perversion, tonics may be advantageously combined with medicines which increase secretion, (§ 174.) Such a combination is presented in most of those remedial agents which have obtained the appellation of *alterative*, and which would seem to be especially suited to oppose to the diseased element under consideration, if they really possessed the virtues ascribed to them.

Nutrition is also effected by the property of secretion, (§ 158;) but inasmuch as its changes cannot be understood without a previous knowledge of the blood and its constituents, and involve the complex subject of structural disease, their consideration will be deferred.

DISEASES OF THE CONSTITUENTS OF THE BLOOD.

179. The pathological elements (§ 107) which we have hitherto considered are those of the vital properties of the elementary solids. We now proceed to examine the morbid changes of the blood. These, like those of the solids, may be often traced to in-

dividual elements, of which the blood is composed, the changes of which must be viewed as ultimate elements of disease, and are therefore properly included in the present division. But as the blood also operates as a whole, compound indeed in itself, but simple in its influence on vital functions and structures, it forms a proper connecting link between *ultimate* and *proximate* elements of disease. So, also, inasmuch as it is, in some respects, an organized compound, the materials of which are changed, together with its functions, and contributes to the production of change of structure in the solids of the body, the consideration of its changes will be a proper introduction to that of alterations in the circulation, which induce changes of structure, and thus lead to structural diseases themselves.

180. We have found that blood is the support of all the vital properties; and in describing their variations, we have been obliged to refer frequently to differences in the supply or quality of this fluid, both as causes and as consequences of these variations, (§ 113, 127, 131, 159, &c.) We have now to examine the properties of the blood itself, and, first, those which are most elementary, or referable to its respective constituents.

The circulating blood consists of red particles, colourless globules, and liquor sanguinis; but as the latter is compound in function as well as in constitution, it is necessary to specify its chief constituents. We have, then, to consider—

1. The red particles, 2. Fibrin and colourless globules, 3. Albumen and other dissolved animal matters, 4. Oil, 5. Salts, 6. Water,	in excess, defect, and alteration.

181. Other changes affecting the entire blood are—

7. Changes by respiration.
8. ——— by secretion.
9. ——— by nutrition.
10. ——— by foreign matters.

182. The average natural proportions of the chief constituents of the blood, according to Lecanu, and adopted by Andral and Gavarret as a standard, are 127 red globules; 3 fibrin; 72 animal matter in the serum; 8 salts; 790 water.*

* Annales de Chimie et Physique, Nov. 1840, p. 229.

SECTION VII.

RED PARTICLES.

183. The red blood-discs appear to be the part of the blood on which its vivifying and calorific properties chiefly depend. Thus Prevost and Dumas found that animals bled almost to death could be restored by injecting into their veins a mixture of red particles and serum, even when the fibrin had been removed; yet the serum alone failed to produce any such effect. It is therefore to be supposed that the red particles are the part of the blood required in transfusion in cases of hemorrhage. Andral, Gavarret, and Delafond, remarked that in domestic animals the vigour and beauty of the animal were proportioned more to the amount of red particles in the blood of the animal than to any other constituent; aud that improvement of a breed by crossing was marked by an increased proportion of this element.* The red particles are supposed, by Liebig and others, to be the means by which oxygen is carried throughout the circulation, and brought to act on the various textures. Their proportion varies considerably in health; it may be stated generally at 120 or 130 in 1000 of blood.

184. *Excess of the red particles* might therefore be expected to cause a general excitement of the vital properties of the body, (§ 183.) Accordingly, Lecanu found that they exist in larger proportion in persons of sanguine temperament (§ 38) than in others, and more in males than in females. Andral and Gavarret detected an excess in the early stage of inflammations and fevers, especially eruptive fevers, as measles and scarlatina.[?] In sanguineous plethora, also, and in hæmorrhagic diseases before much blood is lost, they were in excess, in some instances rising to 185 in 1000 of blood. The obvious sign of the abundance of red particles is the florid colour apparent in the lips, cheeks, gums, and other vascular parts; the deep-blue colour of the superficial veins; and the fine deep crimson which a thin film of blood gives on a white plate. The functions, animal heat, and muscular irritability are in an elevated state, bordering on or passing into febrile excitement.

[In thirty-five venesections of plethoric individuals, the mean of the red corpuscles was 141; maximum, 154; minimum, 131. (Andral.)—C.]

* Ann. de Chimie et Physique, Juillet, 1842.

185. The *red particles are defective* in persons of the lymphatic or leucophlegmatic temperament, (§ 40;) after great losses of blood, (artificial or from disease;) in chlorosis, and in other anæmic states, as those connected with advanced stages of cancer, diabetes, scurvy, and other cachectic diseases; in scrofulous and tuberculous diseases; in the latter periods of fevers, and after severe inflammations; in granular degeneration of the kidney, and other organic diseases attended with dropsy; in diseases of the spleen, and others of malarious origin, (§ 85.) In extreme cases of chlorosis, the proportion of the red particles was found, by Andral, reduced to 28 in 1000 of blood.

The signs of the defect are, paleness of parts naturally coloured with blood, pallid or sallow hue of the skin, pink colour of superficial veins, and a pinkish or light purplish hue of a film of blood on a white plate. The symptoms of such a condition are those which will be more fully described under the head of anæmia; a weak state of the functions generally, of circulation, calorification, digestion, and nutrition, constituting their summary.

[The maximum attained by the red corpuscles in health is 140, whilst the minimum is 110 in 1000. Force and strength of constitution is the condition of the economy favourable to the former, and feebleness, congenital or acquired, to the latter. Sanguine losses, and deprivation of food, produce, as a constant effect, diminution in the red corpuscles, whilst the fibrin, as we shall see, is less constantly and necessarily influenced by these causes. Diminution in the quantity of the red corpuscles may exist as an independent morbid state, or may supervene as an epiphenomenon in other diseases. In 24 cases of confirmed spontaneous anæmia, the mean of the red corpuscles was 64, (Andral.) In the cachectic condition resulting from the poison of lead, so well described by Dr. Tanquerel, the red corpuscles fell to the same mean as in spontaneous anæmia, whilst the other materials of the blood remained unaltered. Certain modifications in the organism may influence the blood, and diminish the quantity of the red corpuscles. This occurs ordinarily in pregnancy. In the neuroses, the blood is remarkably poor in red corpuscles; in phthisis, there is diminution of this constituent, as well as in all chronic organic diseases.—C.]

186. The *red particles* are evidently *altered* in some diseases, the colouring matter being much darker than usual, as in the worst forms of scurvy, in which the blood is said, by Mead, to be changed to a dark brown or green colour: in the Walcheren and other malignant fevers it has been described as pitchy black. Some change seems to occur in congestive typhoid fevers, in which the blood-vessels become stained or dyed of a deep claret colour: this imbibition implies an unnatural solution of the red particles. Pro-

bably the occurrence of petechiæ and ecchymosed patches in these diseases is partly dependent on a similar change. The readiness with which the textures become stained in scorbutic subjects, and in secondary syphilis, seems to indicate an alteration in the colouring matter; all inflammations and ecchymoses in the skin being followed by livid, purple, or copper-coloured stains. The black matter of melanosis seems to be the colouring part of the blood in an altered state: this is certainly true of the spurious melanosis of the intestines.

187. Besides changes in colour, the red particles may probably be subject to alterations in their form, size, and other properties in connection with the medium in which they are placed. It was first observed by Hewson, that pure water causes them to swell, become globular, and burst; whilst saline solutions, containing more salts than serum does, make them shrink in size. These changes are now generally understood to arise from endosmosis and exosmosis: the saline matter drawing the water into or out of the little cell which constitutes the red particle. It has not been ascertained, but it is highly probable that similar changes may take place in the living body, from circumstances which greatly alter the proportion of saline matter and water in the blood. May such change contribute to produce the serious symptoms, and even sudden death, which have ensued on drinking a large quantity of water after great exertion? Has it aught to do with the reaction and irregular excitement sometimes occurring after excessive losses of blood? Or with the symptoms of suffering which animals manifest at the instant of injecting water into their veins?

[In two cases of chlorosis, Andral found the red corpuscles smaller than usual, many of them altered in form, appearing in the field of the microscope as if broken into fragments. A young girl whose blood presented this appearance, became, after two months of appropriate treatment, plethoric; and, at this interval, on the globules being examined, they were found in a perfectly healthy state. In an epidemic typhus which prevailed in different districts of Italy in 1841, M. Renzi, of Naples, states, that the red corpuscles were readily freed of their colouring matter, seemed to have lost their central nucleus, and were altogether less compact and solid than naturally.—C.]

188. The change of the blood from dark to florid, on the addition of saline matter, appears to depend on the increased density and opacity given to the red particles or their nuclei, and to the colourless globules, whereby they reflect light more abundantly and are also rendered less transparent.* Probably the action of oxygen in reddening venous blood is of a similar character.

* Medical Gazette, Sept. 1835.

189. The red particles are distinct structures, living cells, (probably nucleated,) although isolated and floating in a lifeless fluid. Like other nucleated cells, they probably possess the power of secretion and reproduction; but the office and mode of these have not been ascertained; and we can therefore say nothing of their modifications. It has been conjectured that they have other vital properties, such as spontaneous motion, and attractions and repulsions; but there are no unequivocal facts in support of such notions. The motions described by Treviranus, Schultz, and others, may be accounted for on purely physical principles. It is said, that a systolic and diastolic movement in blood particles has lately been observed, by Dr. Martin Barry, in the fallopian tube of a recently impregnated rabbit; but this needs confirmation.

190. Mr. Wharton Jones has described changes in recently drawn blood, which he considers to arise from peculiar attractions subsisting between the particles.* Hewson, Prevost, Dumas, and others, remarked that red particles of new drawn blood cohere together in piles or rouleaus. Mr. W. Jones adds, that this cohesion in healthy blood is temporary only; and that, in a few seconds, the discs may be seen loose and confused; but in blood drawn from a person affected with inflammation, the cohesion takes place earlier, is more firm, and lasts longer than usual; and he considers this the chief cause of the separation of the red particles from the fibrin, which leads to the formation of the buffy coat. We shall notice the relation of this phenomenon to the buffy coat under the head of *fibrin;* but of the cohesion of the red particles we would remark, that it is not certain that it is more than one of mechanical aggregation induced by change in the relative dilution of the liquor sanguinis, or serum, without and within the blood corpuscle. The momentary exposure of so thin a film of blood to the air causes evaporation, which affects the serum before it can reach the interior of the blood particles. At this time they cohere; but the exosmosis proceeding from the individual particles again detaches them from each other. But, without dwelling on this or the equally hypothetical notion that the cohesion is due to a vital attraction, it is not unimportant to observe this property, and the variety which is presented in inflammatory disease. But Mr. W. Jones is premature in assuming that a similar aggregation of the blood corpuscles occurs within the blood-vessels, and is the cause of obstruction in the capillaries in inflammation and other cases of impeded circulation. No such cohesion is seen in the large vessels of a frog's web, when the motion of the blood is arrested by pressure on a vein; and although the blood does coagulate in some of the vessels of an inflamed

* British and Foreign Medical Review, Oct. 1842.

part, this will hereafter be shown to begin with the colourless, rather than with the red particles. (See Inflammation.)

191. Our inquiries as to the pathological causes of changes in quantity and quality of the red particles are baffled by our ignorance as to the origin of these particles. The most plausible hypothesis is that advocated by Dr. Martin Barry, that they reproduce themselves. This does not altogether supersede the older notion that the lungs and the spleen may be the chief seats of their formation, nor that of Mr. Gulliver, that some may be formed from the globules of chyle. Certain it is that in serious and long continued diseases of the lungs or spleen, their quantity is remarkably diminished. But the same diminution is still more remarkable in chlorosis without any visceral disease.

192. *Remedial agents.*—Excess of the red particles may be speedily removed by blood-letting, which reduces these much more than the other constituents of the blood. Low or vegetable diet, and the antiphlogistic regimen generally, produce a similar effect more tardily. It is not certain whether any medicines directly act in a similar way; but probably the continued use of mercury, colchicum and other medicines which largely increase the excretions, (§ 173,) ultimately reduce this element. The remarkable pallidity which accompanies the occurrence of extensive suppuration would also point to the formation of pus as a means of diminishing the red particles, which means may be used artificially in the form of setons and suppurating counter-irritants.

193. To *promote the increase* of the red particles, *where defective*, we might expect nourishing food, especially meat, exposure to invigorating air and light, with tonics generally, to be the proper means. But without experience we could not have anticipated that medicines containing iron should possess such remarkable efficacy in relation to this element of disease. In many cases of chlorosis, under the use of any suitable preparation of iron, the complexion will change from waxy to ruddy, in three or four weeks' time. This subject will again come under our consideration in connection with anæmia.

It has been supposed by Dr. Stevens that saline medicines have great power in restoring to their natural condition the red particles which are changed in typhoid and malignant remittent fevers, (§ 186;) but if these remedies have any power in such maladies, it is very doubtful how much is to be ascribed to this mode of action.

SECTION VIII.

FIBRIN.

194. The trifling difference in composition between fibrin and albumen (a minute addition of sulphur in the first) would scarcely distinguish them; but the self-coagulating property of fibrin is that which makes the distinction obvious, and most important in pathology.* Being the part which causes the coagulation of the blood, with all the varieties which that process exhibits; being the part which constitutes the buffy coat and coagulable lymph; and being probably the material by which textures are chiefly nourished and repaired, its changes must constitute an important element of disease. Although probably not so immediately concerned as the red particles in maintaining the vital processes of respiration, circulation, and innervation, it is yet a representative of the active state of these processes, and of the nutritive and reparative function; and it therefore exists in larger proportion in arterial than in venous blood. It is deficient in new-born animals, but abundant in children and in persons who have been well fed, and are in robust health. The average proportion in health is three in one thousand of blood. (Andral.)

[In some instances the fibrin may reach 4, or descend as low as 2 in 1000, without indication of disease. But it must be borne in mind that these maxima and minima are very rarely compatible with perfect health, and are to be regarded rather as belonging to idiosyncrasies.—C.]

195. An *excess of fibrin*, and of the colourless or lymph-globules, exists in inflammatory diseases, especially those of a sthenic character, and acute rheumatism. In some cases, MM. Andral and Gavarret found it as high as ten per thousand. The proportion of fibrin is also increased during the latter months of

* [From the recent analyses of MM. Dumas and Cahours it would appear to be positively determined that fibrin, so far as regards the four elements—carbon, azote, oxygen, and hydrogen—instead of being identical with albumen, very essentially differs from it. The proportion of carbon, according to these chemists, is ·7 per cent. less in fibrin than in albumen, whilst the proportion of azote is ·8 to ·9 per cent. more. A correct idea of the elementary composition of fibrin may be formed, if we consider it as a combination of casein, or albumen, and ammonia. The same observers have found a vegetable fibrin equally distinct from vegetable albumen. These analyses were conducted on a much larger scale, and a much closer agreement was obtained than by any previous observer; a satisfactory evidence of the accuracy of the methods employed. This view of the chemical composition of fibrin and albumen derives additional weight when we consider the difference in their physiological properties, which is still better marked.—C.]

pregnancy.* These facts have been long known; but in addition to these, MM. Andral and Gavarret found an excess of fibrin in tuberculous diseases, in which we have noticed there is a defect of red particles, (§ 185.) Mr. Gulliver has observed the increase of white globules in blood drawn in inflammation; and I have noticed this as occurring in the vessels. (See Inflammation.)

196. *Deficiency of fibrin* is of frequent occurrence in many diseases and temporary conditions bordering on disease. Its sign is fluidity or imperfect coagulation of the blood when drawn. As venous blood contains less fibrin than arterial, so the quantity is absolutely diminished when the blood is more venous than usual, as in cases of asphyxia or impeded breathing; and in those of cyanosis, in which the venous blood becomes mixed with the arterial through an unnatural opening.† Excessive bodily fatigue and want of sleep expend the fibrin: hence the blood remains fluid in animals hunted to death, (§ 65.) It was stated by John Hunter that the same thing is observed in animals killed by lightning; but this is not always the case. In many instances the blood is found fluid in cases of death from poisoning and other sudden causes. In some of these the absence of fibrin may be attributed to the impeded respiration which is the immediate cause of death, as in some cases of death from hydrocyanic acid, opium, strychnia, apoplexy, dividing the pneumogastric, (Dupuy,) &c. There is, however, some uncertainty about these facts. (See Mr. Blake's experiments mentioned further on.) But in others, as in poisoning with arsenic, sulphuretted hydrogen, and some other pernicious agents, the fluid state of the blood must be ascribed to a more direct operation on the blood itself. So likewise in adynamic fevers, which arise from a peculiar poison, the fluidity or imperfect coagulation of the blood is one of the most remarkable conditions, and seems to be a chief cause of the hæmorrhages, petechiæ, and vibices, which sometimes occur in these fevers. In a case of very low typhoid fever, Andral found the proportion below one in one thousand. The artificial imitations of these fevers produced in dogs inoculated with various morbid or putrid matters, or confined over their exhalations, in the experiments of Gaspard, Majendie, Gendrin, Leuret, and Hamon, exhibited a similar absence of fibrin in the blood, (§ 194.)

The addition of some neutral and alkaline salts to the blood

* In domestic animals the fibrin is diminished before, and increased after, parturition. (Ann. de Chim. 1842.)

† Poor food, or that defective in protein principles, lowers the quantity of fibrin, (§ 63.)

out of the body will diminish its coagulating property; and it has been stated that subsisting on salted food will produce a dissolved or non-fibrinous state of the blood during life; but this statement does not appear to be founded on any well ascertained facts, and is perhaps connected with the notions that salt food is the cause of sea scurvy, (§ 63,) and that the blood does not coagulate in this disease, both of which are erroneous. (See Lib. of Pract. Med., Art. Scurvy, by Dr. G. Budd.)

197. Besides the sign already mentioned, permanent fluidity or little coagulation of the blood when drawn, a defect of fibrin causes a tendency to hæmorrhages, generally of the asthenic kind, and to an unmanageable oozing of blood from any accidental wound or breach of texture. In the same cases, too, wounds do not readily heal, nor fractures unite. In fact, the plastic or reparative process is defective for want of its material, (§ 194;) and for a similar reason, the nutrition of textures which consist chiefly of fibrin, such as muscle, is ill maintained.

198. Majendie found that animals, from whose blood fibrin had been abstracted, were affected with congestions and effusions in the lungs, brain, and other organs, which he ascribes to a cause supposed by M. Poisseuille to be a general physical fact; that very thin fluids pass with greater difficulty through capillary tubes than those of somewhat greater spissitude. But his experiments were too rude and his deductions too hasty to merit confidence; and the obstructions and congestions alluded to might be equally due to the cohesion of colourless or blood particles, or even to little clots of fibrin left by the coarse process employed.

There can, however, be no doubt that a certain spissitude in the blood is favourable to its transit through the hydraulic apparatus of the circulation; and that when this is deficient, various irregularities in the distribution of the blood may occur. Some of these will be mentioned under the head of anæmia: but I may mention here that thin blood is easily thrown into sonorous vibration, and various unnatural sounds or murmurs in the heart, arteries, and veins, may be thus produced. As these are sometimes met with in cases in which the complexion does not indicate a deficiency of red particles, and they are sometimes absent in the most pallid subjects, I am inclined to connect them as much with defect of the fibrin and albumen as with that of the red particles of the blood.

199. *Alterations in the quality of the fibrin* introduce to our notice the important morbid appearances presented by the buffy coat and contraction of the clot of blood.

As the consolidation of the fibrin is the cause of the coagulation of the blood, so differences in the coagulum represent variations in the properties of the fibrin.

200. A large firm coagulum indicates an abundance of fibrin, as well as of red particles, and is commonly presented by healthy blood. A loose coagulum implies a deficiency of fibrin. A small firm clot betokens a proportion of fibrin exceeding that of the red particles; but the smallness of the clot points to another property of the fibrin, which is in excess, that of contraction during and after its consolidation. Again: in this case as in others, the upper part of the clot is commonly more contracted than the lower portion: it is also firmer and contains more fibrin, whilst the lower abounds more in red particles. Here there is evidently a tendency to a separation of the red particles from the fibrin. In other cases, again, the separation is to some extent complete, the red particles subsiding, whilst the fibrin rises to the surface, and on coagulating forms at the top of the clot a layer of a light yellow or buff colour, commonly known by the name of the *buffy coat.*

201. It may be inferred, then, that besides *self-coagulation,* (§ 194,) fibrin possesses a property of *contraction,* and another of *separation* from the red particles; and these properties are presented in different degrees in different states of the system. Let us consider these properties, first separately, afterwards in combination.

202. *Self-coagulation* is generally retarded in inflammatory diseases, and in other cases in which the fibrin is abundant, (§ 195,) its amount is indicated by the firmness and size of the clot. Other circumstances, however, may make the coagulation slow, as warmth and seclusion from the air; whereas cooling quickly, and exposure to the air, as when the blood trickles from the vein, or is drawn into a shallow vessel, hasten the coagulation. The addition of some saline matters, such as common salt, carbonate or sulphate of soda, also retards the coagulation of the blood.

203. The *contraction* of the clot evidently depends on the attraction of the particles of fibrin for one another after the coagulation has begun. By the contraction, the red particles entangled in the fibrin are also drawn together whilst a portion of the serum is squeezed out. The more slow the coagulation is, generally the greater will be the contraction. Hence the upper surface of the clot is often formed more quickly, (§ 202,) and is therefore larger than that below, whilst the middle portions of this large upper film being drawn downwards by the contraction of that below, cause the *concave* or *cupped* appearance in the clot, so commonly seen in buffed blood, (§ 200.) By drawing blood slowly, or in a shallow vessel, the coagulum is speedily formed in

all parts, and adhering to the sides it is not cupped, (§ 202.) The contraction and cupping of the clot being due to the fibrin, might be expected to be in proportion to its quantity; and this is the case in inflammatory diseases. But there is also great contraction and often cupping in chlorosis and some analogous states, in which the fibrin is not absolutely increased; but the red particles being much diminished, the contractile property of the fibrin is not impeded. For a similar reason the contraction is greatest where the quantity of fibrin is greatest, and most completely separated from the red particles. On the other hand, there is little or no contraction where the red particles are in great abundance, as in sanguineous plethora, (§ 184,) or where the aggregation of the fibrin is impaired by the addition of saline matter, (§ 196.)

204. The *separation* of the fibrin from the red particles, (§ 200,) as exhibited in the buffy coat, has attracted much attention, and has been ascribed to various causes. As the fibrin always rises to the surface, and the red particles sink, it is obvious that a chief cause of the separation is the greater weight of the latter, which subside entirely from the upper layer of fibrin before it has time to coagulate. Now, this subsidence will be favoured by three circumstances—1, the tardy coagulation of the fibrin giving more time for the separation; 2, increased specific gravity of the red particles; 3, diminished spissitude of the liquor sanguinis. Now all these three conditions may be fulfilled by adding a little salt to healthy blood as it flows from the vein; and this addition really does produce a separation of the fibrin; but the fibrin thus rising to the surface has neither the contraction (§ 203) nor the firmness of the inflammatory buff, but is gelatinous, like size, and rather resembles the sizy blood sometimes exhibited in scurvy and diabetes. Further: although blood in inflammation is generally slow to coagulate, it is not so always; and in extreme cases, as in acute rheumatism, the buff appears even where the coagulation is speedy, and, according to Schroeder Van der Kolk, is seen in patches and thin films where gravitation would not have promoted the separation.* There must, then, be some other cause for the formation of the buffy coat besides those above mentioned. The great firmness and contraction of the surface of inflamed blood may be ascribed to the increased proportion of fibrin, which is constantly present.

[Whenever there is excess of fibrin, whether relative or absolute, and the coagulation of the fibrin does not occur too rapidly, it will accumulate alone on the surface of the clot, and form a buffy coat. Thus the blood of anæmia is buffed, whilst that of

* Alison's Outlines of Physiology, p. 89.

plethora is not; the buff in the blood of pregnant women is owing to the excess of fibrin relatively to the globules. This explains too the buff in the blood drawn from horses, where there is predominance of fibrin over the red corpuscules.—C.]

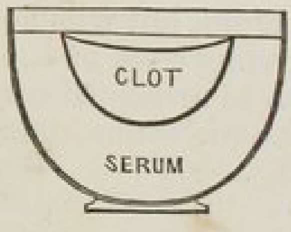
205. Dr. Alison considers the separation of the fibrin in inflammation to be due to a vital repulsion between the fibrin and the colouring matter.* Mr. Wharton Jones thinks that the tendency to separate may be entirely explained by the increased aggregation (before noticed, § 190,) which he observed in the red particles of inflammatory blood: these, by their cohesion, act like a sponge, contracting and squeezing out the fibrin from between them before it coagulates. (Brit. and For. Med. Rev., Oct. 1842, p. 592.) I do not consider this comparison a just one; for, so far as I have seen, the cohesion of the red corpuscles is not in an entire mass, but only in separate piles or rouleaux: these would facilitate the separation, not only by contractile aggregation, but also by sinking through the liquid fibrin more quickly than separate particles would; just as bits of chalk fall to the bottom of water instead of remaining long suspended, as they would do in fine powder. The fact that the red particles do aggregate more completely and for a longer time in inflamed than in healthy blood, is valuable, because it furnishes us with a microscopic test of the inflammatory condition of the blood, applicable, as Mr. W. Jones remarks, to a minute drop of blood drawn from a prick of the finger.†

The subjoined sections of the different appearances of coagulated blood may assist the student to understand their nature and causes.

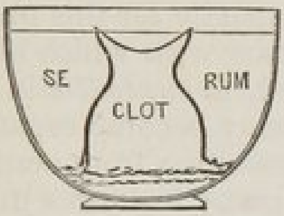
206. This presents uniform coagulation with little contraction. If the clot is moderately firm, the blood is rich in fibrin and in red particles, as from persons in robust health. If the clot is very soft and uniform, the fibrin is deficient, as in typhoid fevers, exhaustion from exertion, &c. If the clot is very soft, especially at the bottom, and the top covered with a soft sizy film, the coagulation has been slow, as in scurvy and in slight inflammations occurring in typhoid fevers.

* Dr. Carpenter suggests that increased attraction of the red particles for each other, and of the molecules of fibrin for each other, would, more consistently with analogy, produce the same effect. (Pr. of Human Physiology, [Am. Ed. p. 430.])

† [See Carpenter's Principles of Human Physiology, Am. Ed. Note by the Editor, p. 430, 431, and Ed. Med. and Surg. Journal, Oct. 1843.]



207. Uniform coagulation with great contraction, which takes place where the proportion of fibrin much predominates over that of the red particles, as in chlorosis. The relative as well as the absolute quantity of the fibrin is indicated by the firmness of the clot. This appearance, with a buffy surface, is often exhibited by blood drawn in inflammation in anæmic subjects or in advanced stages, and in phthisis.



208. Blood highly buffed and cupped, as in acute rheumatism and other severe inflammations. The fibrin here presents in a high degree its properties of separation, coagulation, and contraction; having almost abandoned the red particles, which are loose at the bottom of the vessel, and having risen to the surface, where it appears as a tough, contracted, concave, and buffy clot.

209. To exhibit the true properties of the blood in coagulation, it should be drawn by a full stream into a deep or globe-shaped basin or cup, previously warmed, and kept covered over until the coagulation is complete. These precautions retard the coagulation, and favour the separation and contraction of the fibrin. On the other hand, if the blood merely trickles from the vein, as when the orifice is small or the patient faint; or when the receiving vessel is shallow and cold, the blood congeals at once, and prevents the appearance of the buffy coat, (§ 202.) This is one reason why blood drawn at one blood-letting often exhibits a different appearance in different vessels.

210. We have before noticed that the fibrin of the blood may be speedily exhausted by violent muscular exertion, and by serious impediment to the respiration, (§ 196.) These, and the fact that it exists in larger proportion in arterial than in venous blood, seem to point out that it is expended in the nourishment of the muscular and other textures, and is renewed through the agency of respiration. It might be supposed that inflammation increases its quantity by accelerating the circulation and respiration without adequate expenditure; but although this may be a contributing cause, particularly in acute rheumatism, it is not sufficient, for the quantity of fibrin is not proportioned to the frequency of the pulse or respiration; it is often much increased before these are materially affected, and in idiopathic fevers it is diminished, although the breathing and pulse are commonly accelerated. In fact, various circumstances, to be detailed hereafter, render it probable that the increase of fibrin during inflammation has its origin in the vessels of the inflamed part. There is little doubt that

fibrin is elaborated from the albumen of the serum, but whether through the agency of the red particles, as secreting cells, as supposed by Wagner, Henle, and others, or by that of nucleated corpuscles in the blood and lining the vessels of textures, is uncertain; but the former opinion seems the most probable.

211. Fibrin, or the buffy coat of the blood, is also the material of which new membranes and cicatrices are formed, constituting the *coagulable lymph*, which is the plasma or basis of the constructive or reparative process. But in its capacity for this process, fibrin exhibits some varieties. The plasma with which old textures are nourished, and new ones formed, is *euplastic* in a healthy state, having a capacity of life, and may become organized in a high degree, as in false membranes resulting from acute inflammation in a healthy subject. But in many instances this capacity is degraded, and the nutritive material is *caco-plastic*, susceptible of only a low degree of organization, as in the indurations resulting from low or chronic inflammation, fibrocartilage, cirrhosis, gray tubercle, &c., or it is *aplastic*, not organizable at all, as in pus, curdy matter, yellow tubercle, &c. It is a point of great importance, that the quantity of fibrin in the blood, and the facility with which it may be effused, are by no means in proportion to its plasticity, or capacity to become organized; thus it is abundant in the blood, and freely effused in the inflammations of scrofulous or tuberculous subjects, although the products of these inflammations and of nutrition are commonly caco-plastic or aplastic. It is interesting to observe that in these cases also the red particles are defective in number.

212. The rudiments of organization may be seen in the buffy coat in the form of nucleated globules or cellgerms, scattered among bundles of minute fibres, crossing each other in various ways.*

[The observations of MM. Andral and Gavarret on this point are highly interesting. They took the blood of a patient labouring under pneumonia, and as soon as the yellow opaline liquid appeared above the mass of red corpuscles, a drop was placed under the microscope. Besides the red corpuscles, the field of the microscope was filled with granular corpuscles, (lymph corpuscles.) When the buffed coat was nearly solidified, it was reexamined; a great number of fibres of extreme tenuity were now seen, resembling very long and fine threads, interlaced with each other in various directions, with intervening spaces more or less large. The fibres, finally, assumed the appearance of a genuine net-work. At first they were few, and scarcely visible, but be-

* Gulliver's Notes to Gerber's General Anatomy, App. p. 19.

came more and more numerous, and soon filled the entire field of the microscope. In proportion as they multiplied they formed superimposed planes, and the appearance of a simple net-work was replaced by that of felt, but the fundamental form remained always reticular. As the solidification of the clot increased the interlaced fibres diminished, and it finally became a confused mass. Repeated experiments gave the same results.

If the sero-fibrous fluid obtained from the globules by treating the blood with the sulphate of soda be examined under the microscope, you will observe the same reticular arrangement in the flocculi which speedily appear in the liquid. There is no doubt that several of the elementary tissues of the body are formed in this way. (550.) C.]

It is probable that the globules are identical with the colourless or lymph globules of the blood, which are pretty good representatives of the proportion of fibrin in the blood. In the frog, the white globule in the blood and the cellgerm of lymph seem identical; but Mr. Gulliver observes, that in mammalia the latter is considerably smaller in size: it is probably younger.

213. The coagulation of fibrin is promoted by the contact and motion of a rough solid: thus by stirring fresh-drawn blood with a stick, the fibrin adheres in shreds to the stick. The same property is exhibited within the body in the deposition of lymph (vegetations) on rough surfaces within the heart and great vessels, and it is probable that the fibrinous concretions called polypi, which are found after death in the heart, are formed on its irregular surfaces, as its failing motions cause agitation more than propulsion of the blood.

Remedial agents.

214. *Excess* of fibrin (§ 195) is less directly reduced by blood-letting and low diet, than is excess of the red particles; yet these are the chief means of lowering the quantity of fibrin in the blood. It would probably be found that purgatives, and other remedies which increase much the more solid secretions, diminish the fibrin. A similar property has been ascribed to mercury, to alkaline salts, to iodine, and to antimony. I know of no positive facts in support of this notion; but it is favoured by some analogies, and seems well worthy of experimental investigation. The operation of salts and alkalies in this way was probably suggested by their property of dissolving fibrin out of the body.*

* My friend Mr. Blake has made many experiments of injecting various saline and other fluids into the veins, and he has furnished me with a summary of their effects on the blood, as found after death.

The blood was found coagulated after the injection of the following matters:—Liquor potassæ (firmly); carbonate of potass (firmly); nitrate of potass (firmly;

215. According to the views of Liebig, subsisting chiefly on saccharine, amylaceous, or gelatinous articles of food, must reduce the fibrin and albumen of the blood; and such food is found by experience to be the best in inflammatory diseases, in which excess of fibrin is a chief element. Is the reputed efficacy of the "cure de raisins," in tuberculous disease, connected with the absence of protein compounds in the food? Bodily exercise reduces the fibrin, and may be advantageously employed with this view in sthenic plethora; but is not admissible in inflammatory diseases. Neither can we suggest any practicable mode of lessening the fibrin by lowering the function of respiration, on which its supply seems to depend, unless narcotics, which impair many organic functions, have some action of this kind. The known utility of opium, aconite, &c., in rheumatism and low forms of inflammation, in which excess of fibrin is a constant element, makes this matter deserving of some research.

216. *Deficiency of fibrin* (§ 196) is to be remedied by assisting those functions on which its supply depends, particularly those of digestion, respiration, and assimilation, and by avoiding its expenditure in too much exercise and other exhausting processes. If the digestive organs will bear them, meat, eggs, bread, and other articles of diet abounding in the protein compounds, should be taken. The digestive and assimilative functions may be assisted by stimulants, bitters, quinine, and the mineral acids, which, from their power in stopping passive hæmorrhage, and in augmenting the muscular strength, seem to promote the formation of fibrin more directly than by their mere operation on the digestive organs. To improve the function of respiration, besides attempts to remove or diminish any disease from which it may suffer, the free access of pure cool air to the lungs should be secured. The injurious effect of exertion is exemplified in the relapses which it often induces in continued fever, in which defect of fibrin in the blood is a chief element. Fatigue of every kind, and wakefulness, should be carefully avoided, and sleep obtained by narcotics, if it do not come naturally. In case of any defi-

blood scarlet); nitrate of soda; nitrate of ammonia; nitrate of lime; nitrate of baryta; chloride of calcium; chloride of barium, chloride of strontium; sulphate of magnesia; sulphate of copper; acetate of lead; arsenite of potass; nitric acid (strongly); narcotin (firmly); tobacco; strychnia (moderately); conium; hydrocyanic acid; euphorbium; and water in quantity.

The blood was not coagulated, or imperfectly so, after injection of caustic soda, carbonate of soda, sulphate of soda, ammonia, nitrate of silver, sulphate of zinc, sulphate of iron, phosphoric acid, arsenic acid, arsenious acid, oxalic acid, infusion of galls, of digitalis, alloxan.

Some of these results are different from what might have been expected; instance the decided coagulation with potass and its salts, especially nitre, and the fluidity with nitrate of silver, sulphate of zinc, infusion of nutgalls, which have been commonly supposed to possess a coagulating property.

ciency of fibrin from the presence of a febriferous or putrescent poison in the system, it is not to be expected that fibrinous food, rest, or any other means, can remove the deficiency, so long as the poison remains in active operation. This poison, by its septic or analogous influence, interferes with the vital process by which the fibrin is formed. But no sooner does the influence of the poison subside, as evidenced by improvement in the symptoms, than the quantity of fibrin increases; and this sooner than could be explained by any increase of nourishment taken. (Andral and Gavarret.)

217. Very little is known of the power of remedies to correct changes in the *quality* of the fibrin of the blood. The increased properties of separation (§ 204) and contraction (§ 203) manifested by blood in inflammation, are reduced by blood-letting and other antiphlogistic remedies, even more constantly than the excessive proportion of fibrin is by the same means; but they seem to be soon reproduced if the inflammation continues. Thus, although the last cup drawn in blood-letting may exhibit none of the buffed and cupped appearance presented by the first cups, yet blood drawn a few hours after often shows as much as any taken before. Knowing that this speedy recurrence of morbid properties in the blood depends on the influence of the local inflammation, we see the necessity of fully using local means, together with those calculated to operate on the system.

218. Blood-letting and other general antiphlogistic remedies, if they do not remove local inflammation, may render its products more injurious by lowering their plasticity, (§ 211,) and approximating them to tuberculous and other aplastic deposits. Thus chronic inflammation continuing after the full application of the antiphlogistic treatment, almost surely tends to produce degenerated changes of structure, over which remedial art has little power. In connection with this subject, therefore, we see how desirable it is that inflammations should be removed before they become chronic; and when there is a risk of their becoming so, it should be an indication to improve the condition of the blood by a tonic and nutritive plan, at the same time that local antiphlogistic measures may be necessary for the lingering inflammation.

219. A similar tonic treatment is still more indicated in scrofulous, chlorotic, and other cachectic states in which the fibrin, although less abundant than in inflammation, is yet copious in proportion to the scanty red particles, (§ 211.) Hence the tendency to the deposit of imperfect fibrin, even independently of inflammation; and besides means calculated to improve the nutrient functions and to raise the character of their product, it may be necessary to use remedies likely to keep the fibrin dissolved,

and to prevent its deposit in its aplastic forms. Alkalies and iodide of potassium have some claims to these properties.

SECTION IX.

ALBUMEN AND OTHER ANIMAL PRINCIPLES DISSOLVED IN THE SERUM.

220. These form a considerable constituent of the blood, amounting on an average to seventy-two per thousand in health. It is generally supposed that the albumen of the serum is chiefly useful as affording the material from which the plasma (fibrin) is elaborated; but it is by no means certain that some textures, such as those less highly organized, composed of albumen and gelatine, may not be formed at once from the constituents of the serum. The albumen is further useful in giving to the serum a consistency favourable for its circulation, and for suspending and preserving the red corpuscles, and in blandly sheathing the acrimony of the saline constituents. The quantity of albumen may be estimated by the specific gravity of the serum, which in healthy subjects averages at about 1030.

[There is about 68 to 70 of pure albumen in 1000 parts of blood, independent of the organic and inorganic elements of the serum.—C.]

221. *Excess of albumen* exists in most cases of inflammations and fevers, especially during their more active stages. Its increase is not, however, in proportion to that of the fibrin. Its relative proportion is much increased in epidemic cholera; but this is rather due to the removal of the water of the blood. Albumen is the principle least affected in its proportions by disease. Very poor living, long continued, extensive hæmorrhages, and other drains on the system, will pretty surely reduce it in common with the other animal principles of the blood; but good living has less power in raising it above the natural standard.

222. *Deficiency of albumen* in the blood is most remarkably met with in cases of albuminuria, or disease of the kidney with coagulable urine; and this deficiency precedes the diminution of the red particles, which takes place in the advanced stages of this disease. Dr. Bright found in a patient with albuminuria, the specific gravity of the serum as low as 1013. (Bright's Reports, vol. i. p. 85.) Dr. Babington found the specific gravity of the serum in a case of diabetes as low as 1024; in another 1027, although that of the blood was higher than usual, 1061. In this

case the serum was milky. (Cycl. of Anat., &c., Art. "Blood.") In their later researches, MM. Andral, Gavarret, and Delafond, discovered a remarkable diminution of the albumen in dropsical sheep affected with the rot, (a watery state of the blood, with distoma in the liver.) Sheep in a cachectic state, with deficiency of red particles, but without entozoa, were not dropsical, and in these the albumen was found undiminished. It is therefore most probable that the cases of cachexia, or anæmia, attended by dropsy, owe this concomitant to a defect of albumen in the blood. It is this principle chiefly that gives the blood liquor its spissitude, which renders it more fit to pass along the vessels, and prevents it from transuding through their walls. This deficiency of albumen, therefore, seems to be a chief constituent of the dropsical diathesis.

SECTION X.

OIL.

223. The oil or fatty matter in the blood sometimes is so much increased as to give a milky appearance to the serum; but it is not known with what pathological conditions this or other variations in the fat of the blood may be connected. It has been observed to occur not only in fat subjects. Hewson noticed it in the blood of three plethoric individuals. Dr. Babington met with an extreme degree of it in a case of advanced diabetes. This physician states that he has found milky serum of low specific gravity, indicating a defect of albumen; and he suggests that the fat might originate in a change in the albumen. This would not accord with the views of Liebig. The notion of Haller, that the milkiness of serum was caused by an admixture of chyle, does not seem exact; the whiteness of the latter being due to an infinity of minute molecules described by Mr. Gulliver. Under the more probable idea that milky serum derives its increase of fatty globules from absorption from fat textures, it should be met with during any rapid diminution of bulk of the body.

224. The increase of fat in the textures is probably preceded and accompanied by its presence in excess in the blood; and the circumstances which promote obesity must operate through the composition of this fluid. Of these may be mentioned fat, sweet and farinaceous food in excess, without disorder of the digestive organs; full living, without exercise. Exercise tends especially to reduce the fat of the body; probably by causing its combustion in respiration, whilst muscular textures are increased by the same influence.

SECTION XI.

SALINE MATTER.

225. It is not known that the salts of the blood are *augmented* in any diseases. It has been surmised, that the thirst caused by taking much salt or saline water is due to a febrile excitement which the salt in the blood induces. But this is by no means certain; for this thirst is not generally attended with increased heat of skin. There may be thirst without fever, although fever is often accompanied by thirst.

226. Diminution of saline matter in the blood has been said, by Dr. Stevens, to take place in yellow fever and other pestilential diseases, and to cause so dark and grumous a state of the blood, that exposure to air will not, as usual, render it florid. This fact has been more distinctly ascertained by Dr. O'Shaughnessy, with regard to malignant cholera, in which the defect of saline matter and water seems to be the immediate cause of the obstructed circulation, lividity, and collapse, so remarkable in that terrible disease. Accordingly, Dr. Mackintosh found the blood extensively coagulated in the heart and large vessels. Hence the temporary efficacy of injection of saline solutions into the veins of cholera patients; it seemed at once to renew circulation, respiration, warmth, and other functions—life, in fact, to the patient—as if the saline solution were all the thing needed. But this defect of serum in the blood is only an effect of the excessive evacuations from the stomach and bowels; and if these go on, the good effect of saline injections is soon exhausted.

227. The presence of a certain amount of saline matter is essential to the preservation of the red particles in their natural size and form, and probably, likewise, to the liquidity of the fibrin. There can be no doubt, therefore, that, in the extreme cases of cholera just mentioned, the blood coagulates in the vessels for want of saline matter, and the red particles become dissolved and altered. The researches of Andral scarcely support the notion that similar changes take place in typhus fever, as supposed by Dr. Stevens. If saline medicines are useful in common continued fevers, it is a question whether it is in this way, by supplying what is defective; it may rather be by augmenting deficient secretions, (§ 171,) and tending to remove or counteract septic influences present in the system, (§ 98, 105.)

SECTION XII.

WATER.

228. It is obvious, from what has been already noticed, that the proportion of water in the blood increases as that of the animal contents decreases. Thus, after extensive hæmorrhages, and in chlorosis and other cachectic states attended with anæmia, the blood is more watery than usual. [In a woman who had suffered from abundant and repeated metorrhagias, the blood contained only in red corpuscles 21; in fibrin 18; in solid matters of the serum 61; whilst the water was raised to 915 in 1000. (*Andral*).—C.] The effect of this state of the blood is to cause a tendency to dropsical effusions and fluxes, besides the consequences which result from a deficiency of the other constituents of the blood.

229. I have before suggested a question, (§ 187,) whether the serious functional disturbance sometimes following the ingestion of very large quantities of liquids, particularly after exertion, when absorption is active, may not in some degree arise from the too copious and sudden addition of water to the blood. Certainly temporary plethora, with palpitation, feeling of oppression or dyspnœa, often results from the too free ingurgitation of liquids, and is not removed until perspiration, or a free flow of urine, relieves the distended vessels. These symptoms are most distinctly observed where some permanent disease of the organs of circulation or respiration incapacitates them for the increased task. Hence the aggravation of the symptoms of disease of the heart and lungs, by too much drink. The colliquative sweats in phthisis seem to arise from a similar cause, and may often be relieved by a judicious reduction in the quantity of liquid food.

230. *Deficiency of water* in the blood is exemplified in epidemic cholera, in which the specific gravity of the serum has been found as high as 1045 (Lecanu), which implies a reduction of nearly half the natural proportion of water. Some diminution probably takes place in other diseases, attended by profuse watery discharges, such as diarrhœa, diabetes, and excessive sweating. In these cases, the smallness of the pulse, and sometimes the shrunk appearance of the surface from the undistended state of the vessels, are signs of the diminished bulk of the circulating fluid; and thirst pretty constantly points out the mode which nature prompts to remedy the defect. In the same way, exposure to heat, especially if continued, and prolonged violent exercise, expends the water of the blood, and causes the feeling of

thirst through which it may be restored. Long abstinence from liquids has a similar effect.

It has been already mentioned, that the extraordinary decrease of the water of the blood which occurs in malignant cholera renders the blood so thick, that it cannot circulate freely, and this change is the chief cause of the cessation of the pulse, lividity, and other signs of obstructed circulation. No such effect is known to follow from any of the other causes of deficient water. The operation of heat and continued exertion is not simple, and therefore not referable to this principle only. Abstinence from liquids for two or three days induces languor, small and easily accelerated pulse, a somewhat pasty state of the mouth, and scantiness and turbidity of the urine, but little derangement of other functions. The digestive process, which might be expected to suffer, in some cases at least, shows no symptoms of disorder.

231. We thus have means of increasing or reducing the water of the blood by increasing or diminishing the liquids drunk; and these expedients may be usefully employed in the cases above mentioned. But these expedients in their extremes also furnish us with therapeutic agents of more extensive power. Drinking large quantities of water may, in a salutary manner, excite the whole vascular system and its connected secreting organs, and may thus wash out of the blood various effete or noxious matters; and this is a chief good which the "water-cure" sometimes effects. The free use of liquids is supposed, by Prout, to prevent the formation of lithic acid, or, according to Liebig, it facilitates its conversion into urea. On the other hand, a total abstinence from liquids for two or three days is an effectual mode of stopping fluxes, and of relieving catarrhal inflammations and congestions. Either plan exerts an alterative operation on the circulation and secretions, which, if more studied, may perhaps be turned to good account in the treatment of many diseases.

SECTION XIII.

CHANGES IN THE BLOOD BY RESPIRATION.

232. The process by which venous blood is made arterial, and rendered fit for its purpose of maintaining the life and functions of the several parts of the body, is liable to variations; and the resulting differences in the state of the blood form an important element of disease.

The conversion of venous into arterial blood comprises the absorption of oxygen, the removal of some carbonic acid, a slight increase of fibrin, and possibly other changes. Each of these elements of the process is probably concerned in giving to arterial blood its fitness for its function; the absorbed oxygen, by its affinity for the hydrogen and carbon of the blood and textures, aiding in those processes by which these are renovated in function as well as in structure and heat is evolved; the renewal of fibrin supplying the expenditure of the plasma, particularly in the muscles; and the removal of the carbonic acid being the excretion of a noxious matter.

233. It is doubtful whether this change is ever carried on in *excess;* for by an admirable adaptation, the activity of respiration is proportioned to the rapidity of the circulation and the corresponding need of change in the blood. Thus exercise, which accelerates the circulation and changes of the blood, also augments the breathing movements. In fevers also, the frequency of the pulse and of respiration is increased; but the muscular strength being much impaired, it is doubtful whether the rapidity of the circulation or the real amount of the respiratory changes is generally augmented in proportion. It has been said, that in acute rheumatism the circulation and respiration are too active for the wants of the system, and that the blood reaches the veins without having wholly lost its arterial character. If this were true, it might in some measure explain the great increase of fibrin in the blood in this disease; but the fact is not well established.*

234. *Defect* of the change in the blood by respiration is a common and important element of disease, and constitutes a chief feature of affections of the respiratory apparatus. Being the essence of the special disease *asphyxia* or *apnœa*, its minute consideration belongs to special pathology, and we shall here only describe it in its more general characters.

The amount of mischief arising from defective respiration varies greatly according to the sudden or the gradual supervention of the defect. An acute attack of the organs of respiration may

* It seems to me that Professor Liebig has given too mechanical a view of the change of the blood in respiration. He appears to consider the increased arterialization of blood, during exercise and on exposure to cold, to be a necessary consequence of the greater amount of air inhaled, in one case by accelerated movements of the chest, in the other by the greater density of the cold air. But if the extent of the changes wrought by respiration were in exact proportion to the quantity of oxygen received into the lungs, how easy would it be to increase them (and thereby animal heat also) by voluntarily augmenting the respiratory movements. I cannot but think that the proportion of oxygen absorbed, and of carbonic acid formed, depends more on the condition of the blood brought to the lungs; and that the respiratory movements are regulated by this. Thus the increased oxygenation of the blood is a consequence, not a cause, of greater changes previously wrought in the blood itself.

prove distressing, and even fatal, by an impediment to the breathing, much smaller than that caused by chronic diseases, the gradual infringement of which may be scarcely perceived. Thus, too, persons affected with extensive emphysema of the lungs are habituated to an imperfect state of respiration, which is shown by a constant lividity of the lips and cheeks: such an appearance would be a sign of approaching death in other persons. The cause of this difference is not merely the general fact that sudden changes produce more effect than slow changes, but it lies chiefly in the fact that the importance of the respiratory function varies under different circumstances. When the several parts of the body, especially the muscular, are in a state of full activity, more breath is needed to remove from the blood the noxious effete matter which always results from functional exercise. Hence in such a condition (which is that of health) the respiratory process cannot be abridged without serious disorder. This disorder is first obvious in the increasing feelings of oppression and suffocation which the want of breath causes, and which excite forced exertions to breathe. If these exertions still fail to duly aerate the blood, it is partly arrested in the lungs, right compartments of the heart and veins, and part passes in an imperfectly arterial state to the left side of the heart and arteries.

235. The phenomena of asphyxia are thus compounded of—1, accumulation of blood in the venous system; 2, diminution of blood in the arterial system; and 3, deficiency of oxygen and excess of carbonic acid in the blood. These several conditions cause injury to the vital functions, both by the want of a due supply of blood, and by the bad quality of that blood, which is injurious,—negatively for want of oxygen, the proper exciting agent, and positively from its excess of carbonic acid and other excrementitious matters which are sedative. The symptoms induced are also of two classes—1, those implying failure of function, such as muscular debility, feeble action of the heart, coldness of the surface and extremities, and abolition of the senses and mental faculties; and 2, those arising from congestion and the noxious influence of the black blood, such as palpitation, flashes in the eyes, noises in the ears, delirium, muscular spasms, &c. Each of these sets of symptoms may predominate in different cases, and this causes a variety in the phenomena of asphyxia, which has not been sufficiently noticed by writers on this subject.

236. But we have to notice the other mode in which the changes by respiration may become defective, that occurring gradually, or when the functions are not active. It is well known that hybernating animals breathe scarcely at all, and yet they live; and this is obviously because their functions are reduced to an extremely torpid state. So, too, animals newly born

will bear the privation of air for a much longer period than those which are older; and it has been supposed that in adults failure of the heart's action by syncope retards the operation of asphyxiating causes. (Dr. Carpenter, on Asphyxia, Library of Med., vol. 3.)

237. Although man cannot be reduced to the torpidity of hybernation, yet it is certain that he may be brought to bear a defect in the respiratory changes, which would be fatal in a few minutes under common circumstances. This is seen when the defect is congenital, as in those affected with malformations of the heart causing cyanosis; and it is also seen where the defect is very gradually induced, as in the case of emphysema of the lungs.

238. In cases of cyanosis, (the blue disease, in which, from malformation of the heart, some venous blood passes into the arteries,) we have the opportunity of observing the more essential effects of defective arterialization of the blood. Individuals thus affected are in a lower scale of animation. The slower processes of nutrition and secretion seem to go on pretty well, but the muscular power is low; slight exertions bring on symptoms of faintness, palpitation, suffocation, or insensibility; the animal heat is lower than natural, and there is greater suffering from the influence of cold. In short, all the powers of body and mind are slender, and are easily disordered by any circumstances which tax their activity. In the few that reach mature age, there is no sexual passion, which seems to be a happy provision against the chance of perpetuating a malformed race—human reptiles. The subjects of cyanosis are said to be very liable to hæmorrhages, and when these occur spontaneously, or from accidental causes, it is very difficult to stop them. This must be ascribed to a defect of fibrin which we have already found to occur where the changes of the blood by respiration are imperfect, (§ 196.) The same defect occurs in the fœtus.

239. In connection with the scantiness of fibrin in the blood, when the respiratory changes are defective, we must notice the weakness of the muscles generally, which are probably nourished by the fibrin. This weakness is often observed in the subjects of extensive disease of the lungs, especially emphysema. In these same subjects the deposition of fat is, on the other hand, often excessive, which agrees very well with Liebig's idea that respiration directly consumes the oily parts of the blood; the respiration being defective, the fat accumulates, (§ 224.)

240. *Remedial measures.*—Besides the obvious indication of endeavouring to restore the respiratory function where it is defective, the view which we have taken of the mode in which the

defect is hurtful, suggests means by which its injurious effect may be diminished. Thus circumstances which lower the activity of the functions often give relief. Of these complete rest of body and mind; warmth to the surface and extremities, whilst air is supplied cool and fresh to the face and air passages; and various sedatives, which reduce the circulation and other functions to a lower standard (or, in the language of Laennec, diminish the want of breath,) such as digitalis, conium, hyoscyamus, &c., are the chief. Other medicines, such as æther, belladonna, stramonium, lobelia, &c., which sometimes relieve dyspnœa, probably act in another way, by relieving spasm or other impediments to the respiration.

241. In extreme cases, bordering on asphyxia, the enfeebled circulation may require stimulants, and the engorgement of the venous system may indicate depletion; in different instances each of these conditions may most need attention, and sometimes both must be treated in the same case.

242. Experience has not yet furnished us with the means of arterializing the blood by any other process but that of respiration. This process may in some cases be aided artificially, either by mechanical means, as inflation of the lungs, electricity applied to the muscles of respiration, the diaphragm, and abdominal muscles alternately; and by bronchotomy;—or by chemical means, the supply of oxygen or nitrous oxide for respiration. Whether the internal administration or the injection into the veins of saline and other matters containing much oxygen in loose combination, such as the chlorates, nitrates, and some peroxides, may be made in any degree to supply the defect of respiration, is uncertain, but it deserves more extensive trials than it has received. If these matters could furnish oxygen to the blood, they would yet leave undone the other office of respiration, the removal of carbonic acid. Might this be accomplished by the administration of free alkalies? In some cases of asphyxia by carbonic acid gas, I have thought that some benefit in the progress towards recovery was derived from the use of liquor potassæ, with chlorate of potash. Perhaps warm baths containing these ingredients might be of some use.

243. The congested state of most organs which occurs when the respiratory process is imperfect, renders necessary remedies suited to remove this state. The lungs, the brain, and the liver, suffer most. The best remedies in these cases are mercurial, and other medicines which act freely on the secretions, (§ 173.) Probably these remedies act in part by making the liver assist the lungs in the office of decarbonizing the blood. The speedy relief afforded to dyspnœa by a bilious diarrhœa has several times seemed to me to countenance this notion.

244. When from disease the respiratory changes are reduced it becomes an object not to increase the hydrocarbon of the blood by the use of food abounding in fat or containing spirit, but to make lean meat and other fibrinous articles, with farinacea and fruit abounding in vegetable acids, the chief sustenance.

245. There is little to be said on the subject of *excess of changes in the blood by respiration*, as it is not certain that such a condition ever exists as an element of disease. It has been supposed that in most sthenic febrile diseases in which the function of respiration is not impaired, this function must be more active in proportion to the accelerated circulation. Acute rheumatism gives an example of this kind, and Dr. Christison states that the blood drawn from a vein is much more florid than usual. If this be a correct observation, this hyper-arterialization of the blood may perhaps account for the unusual quantity of fibrin which it presents in this disease. I must, however, remark that I have found the excess of fibrin in cases in which there had been no remarkable acceleration of the pulse or respiration. We shall see hereafter that the increase of fibrin is connected rather with the local inflammation than with the fever.

246. From the experiments of the late Mr. Broughton, it appears that when animals are confined in oxygen gas, they in the course of a few hours die comatose: the respiration first ceases, whilst the heart continues to beat with vigour, and the blood, even in the veins, is quite florid: it also presents the arterial character of very speedy coagulation. It appears, then, that excess of oxygen injures first the nervous function, (§ 154;) but whether it does so by exhausting it by previous excitement, or by the coagulability of the blood, or by the excessive production of carbonic acid, is not decided by any known experiment. The last-named mode is the most consistent with the related phenomena: it can scarcely be doubted that an increase of oxygen in the blood must augment the production of carbonic acid; and that this latter agent may asphyxiate independently of the exclusion of oxygen, appears from the experiment of Rolando: he found that the air tube of one lung of the land tortoise may be tied without materially injuring the animal, but if one lung were supplied with carbonic acid gas whilst the other received air, the animal died in a few hours. (Carpenter's Human Physiology, Am. Ed., p. 396.)

247. Liebig appears to suppose that the poisonous action of hydrocyanic acid and sulphuretted hydrogen is due to their rendering the iron of the red particles of the blood incapable of absorbing oxygen from the air, and becoming thus the medium of its transfer to the blood and tissues: but to this hypothesis it

may be objected that the blood of an animal poisoned with hydrocyanic acid exhibits the usual changes on exposure to the air. Sulphuretted hydrogen does seem permanently to injure the composition of the blood, but not the red particles merely; for it renders the blood fluid, as well as of a dirty red colour. It does not seem consistent with analogy to exclude the fibrin and albumen from a share in the absorption of oxygen, as well as in furnishing the material on which that oxygen afterwards acts.

SECTION XIV.

CHANGES IN THE BLOOD BY SECRETION.

248. Having already noticed this subject under the head of *diseased secretion*, (§ 158,) it will be unnecessary to dwell long on it here.

The most remarkable instance of change in the blood from disordered secretion is exhibited in *defective secretion of urine*, (§ 70, 170.) The extreme effects of this element of disease were shown in animals in which the kidneys had been extirpated, in the experiments first performed by Prevost and Dumas. On the third day after the operation, there came on vomiting, diarrhœa of a copious brown liquid; fever, with heat varying sometimes as high as 110°, and sometimes as low as 92°; pulse very small and frequent; breathing laboured: death ensued from the fifth to the ninth day. After death there were found effusion of serum in the brain, copious mucous in the bronchi, and bilious fluid and fæces in the intestines. The liver appeared inflamed (?) and the urinary bladder much contracted. The blood was more watery than natural, (§ 222,) and was found to contain urea: five ounces of blood of a dog yielded twenty grains of urea; and two ounces of cat's blood, ten grains.

249. The symptoms induced in defective secretion of urine by degenerative disease of the kidneys are very similar to those just mentioned, but more diversified, from the defect taking place in different degrees as to amount and time. Thus in acute cases of albuminuria, or acute aggravations of old ones, there may be low delirium and other typhoid symptoms passing into coma, (§ 129,) suffocative catarrh, obstinate vomiting, diarrhœa, or inflammatory effusions in the serous cavities, any of which may end in death. In slower cases, cachexia and dropsy may ensue, the blood and solid structures becoming altered. All these effects may be traced to the urea and other excrementitious matters being retained in the blood; in their greatest amount acting on the

nervous system as a narcotic poison, (§ 129;) in smaller, acting as an irritant, inducing low inflammations in various membranes and viscera; and in still lower degree causing sundry functional disorders, fluxes, and dropsies, impoverishing the blood, and inducing degeneration of certain textures, (§ 211.) It has been already mentioned that the blood in albuminuria loses its proper amount of red particles, (§ 185,) and of albumen, (§ 222;) and the diminution of these assists in accounting for the weakness, dropsy, and degenerations which commonly ensue in protracted cases. The several results now enumerated may be differently presented in different cases, and the treatment should be guided according to them.

250. The effects on the blood of a defective secretion of bile have not been so accurately determined. The presence of the bile is often obvious in the yellow colour of the serum and fibrin. In several cases of fatal jaundice connected with structural disease of the liver, I have observed extensive ecchymoses on the legs; and I have already stated, (§ 171,) that in most of the cases of purpura which I have seen, there has been imperfect action of the liver, and the most effectual treatment was by medicines which this circumstance would suggest. The presence of bile in the blood, although sometimes causing tingling, pruritus, and cutaneous eruptions, does not appear to produce local irritation and inflammation, or change of the blood and general dropsy, so remarkably as that of urea does. Still it appears from very prolonged cases of jaundice, in which the dropsy is not local merely (ascites), but general (anasarca and hydrothorax), that the blood at last is impoverished, and the whole body becomes cachectic. Andral found that in dropsical sheep, with hydatids in the liver, the albumen, as well as the red particles of the blood, were diminished.

251. The *perspiratory secretion* contains lactic acid and lactates of soda and ammonia, which probably proceed from the transformation or decay of the textures, particularly the muscular. Hence these products abound during great muscular exertion; and when perspiration is checked by external cold, (§ 77,) they may be retained in the blood, causing rheumatism, urinary disorders, or various cutaneous diseases. The very serious effects sometimes resulting from sudden cold on the perspiring body may be partly owing to the same cause, as well as to the disorder produced in the circulation.* Rheumatism is especially liable to

* Dr. R. Willis has recently suggested that checked perspiration may prove hurtful by rendering the skin dry, and therefore unfavourable for vital changes supposed to take place in the cutaneous capillaries. But if this were the only

occur as an effect of cold, where the body is fatigued with much muscular exertion, (§ 30;) and I have frequently observed that the rheumatism chiefly affects the limbs which have been most exercised. Where the skin fails to excrete, an increased task is thrown on the kidneys, whence may result various diseases of these organs; and if these organs fail in the task, the lactic acid accumulates in the blood, and, probably acting as a ferment, (§ 56,) causes the formation of more, and of the kindred products, lithic acid and its compounds: these, in inflammatory subjects, excite rheumatic fever; and in more torpid frames, various local rheumatic or gouty affections. All these cases are frequently remarkable for the acid character of the cutaneous and renal excretions.*

252. The remedies for rheumatism, therefore, should not be merely antiphlogistic, but also of a kind calculated to eliminate the morbid matter from the blood. In slight cases, sudorifics may suffice; but in others, the kidneys and liver should also be excited to assist in the process of elimination, and various combinations of colchicum and alkalies with mercury, opium, and iodide of potassium, will generally effect this purpose very satisfactorily.†

SECTION XV.

CHANGES OF THE BLOOD FROM THE TRANSFORMATION OF CHYLE AND OF THE TEXTURES.

253. The changes of the blood from the transformation of the chyle and of the textures, including the processes of nutrition and reparation, have been examined too little to supply to the pathologist any distinct data. Prout, Liebig, and other organic chemists, have advanced interesting views on these subjects, but they are too hypothetical to be generally applicable to medicine. It seems quite warrantable, however, to connect with these changes two remarkable states of disease, on the pathology of which chemistry has thrown much light, *gout* and other *lithic acid diseases*, (§ 176,) and *diabetes*.

or chief cause of mischief, it might be always removed by the warm bath, or any other means of moistening the surface; so too pernicious effects should always result from a dry state of the skin: neither of these consists with facts.

* In a patient with acute rheumatism, I have found the perspiration on the affected joints more strongly acid than on other parts.

† The advantages of this due regard to all the elements of disease in the treatment of rheumatism may be shown by the fact, that with few exceptions, I have found that three or four days suffice to remove the fever and pain in the severest forms of acute rheumatism.

254. Gout, and the commonest kind of urinary gravel, are now generally considered to depend on the production in the system of an excess of lithic acid. This acid, being a highly azotized compound, is abundantly generated in those who take a large proportion of animal food, and in whom the digestive and assimilative processes are impaired. Hence it is produced by high living and sedentary habits. It is one of the lower forms of animal matter into which the higher principles, fibrin, albumen, gelatin, &c., tend to pass in their progress towards dissolution. Hence it is produced in excess where there is more azotized matter than is wanted for the reparation of the textures, or than the vital assimilating powers can appropriate for this purpose. But it probably results also from the decay of the textures, especially during febrile or inflammatory irritation, during and after which copious deposits of the lithates are seen in the urine.

The morbid effects of an excess of lithic acid will vary considerably, according to its amount and other circumstances. The kidneys are the proper emunctories by which it is eliminated from the blood, and these sometimes suffer from the irritation which it causes; hence nephralgia and nephritis may occur: or the water and alkali secreted with it in the urine may be insufficient to hold it in solution, and it may be deposited in the form of sand or gravel, or calculus in the kidneys or bladder; and various irritations and obstructions in the urinary apparatus may be the result.

But sometimes the kidneys may fail in their power of elimination, (§ 170;) the lithic acid and its compounds then accumulate in the blood, and may cause various irritations and functional derangements, (irregular gout,) until at length some circumstance fixes the irritation on a limb, and a fit of regular gout is the consequence. In this fit, if perfect, inflammation is excited, with more or less febrile disturbance, which subsides as a copious deposit takes place in the urine, showing the removal of the morbid matter, (§ 165.) The more acute and fixed the inflammation, and the smarter the fever, the more abundant is the deposit, and the more free is the patient from disease afterwards. On the other hand, when the inflammation is low, changing its place, and with little fever, it generally tarries long, and the system is not relieved. It is when gout thus lasts long, or frequently recurs, that often its material so accumulates in the joints as to be deposited in the form of a plastery or calculous matter, consisting of lithate of soda, (chalk stones of gout.) This chronic form of gout is connected with a more or less permanent disorder of the digestive or assimilative functions, which renders its treatment more difficult or less successful than that of the more acute forms of gout. In such cases (chronic,) lithic acid seems to be engendered in great abundance, being often thrown off in large quantities in the urine for an indefinite period, yet never leaving the body free. Such cases are commonly either hereditary or those which have been rendered inveterate by intemperate habits, or neglect of proper treatment.

255. In saccharine diabetes, the morbid matter is of a nature quite contrasted with that of gout and gravel, being sugar, which is wholly unazotized; yet it is probably also produced in connection with the processes of assimilation and nutrition—the condition of the urine being only a consequence of disorder in these processes. The analysis of Ambrosiani, Maitland, and others, have proved the existence of sugar in the blood of diabetic patients; and Macgregor has also established the fact of its unusual production during the process of digestion. The appearance of sugar in the urine can scarcely be considered otherwise than as a result of its presence in the blood.* But whether it is formed only from isomeric principles in the food, such as starch and gum, or is also derived from a decay of the textures by a modification of the process in which urea is naturally evolved, or is elaborated out of various principles both in the food and in the blood, is not clearly ascertained. As there is saccharine matter naturally in chyle, it might be supposed that there is, in diabetes, an exaggeration of the process by which this is formed; and that the atrophy and cachexia accompanying the disease result from the draining away of the nourishment of the body *with* the excess of sugar, rather than the converson of all this nourishment *into* sugar. It is now well ascertained that the ordinary animal constituents of the urine are not only present, but are even increased considerably beyond their natural amount.

256. There is a resemblance in the indications of *treatment* in gout and in diabetes, although in the fulfilment of these indications the means to be employed are most opposite. In both cases,

* [The contradictory results obtained with regard to the presence of sugar in the blood of diabetic patients, is due, chiefly, according to M. Bouchardat, to the following circumstance. If you examine diabetic urine at different periods of the day, you will find that an hour or two after meals it is abundantly secreted, contains a considerable proportion of sugar, which successively decreases for the next twelve or fifteen hours; beyond this term, if the patient has eaten nothing, no trace of sugar will be found in the urine. Patients are ordinarily in hospitals bled in the morning, the period the most distant from their meals, and the amount of sugar then in the blood is so minute as to escape detection. By two comparative analyses, M. Bouchardat sustains his position. In a patient bled at nine o'clock in the morning, who had fasted since five o'clock the previous evening, no trace of sugar was detected. In another patient bled two hours after a light breakfast, there was unequivocal evidence of sugar in the blood.—C.]

we must withhold those articles of diet from which the morbific matter is most readily generated. Thus abstinence from animal food and stimulating condiments and beverages, in the case of gout—the exclusive use of these very articles, to the avoidance of all saccharine or farinaceous substances in the case of diabetes —constitute a successful part of the treatment. In both cases, it is indicated to improve those processes of digestion and assimilation, from a perversion of which the morbid matter is probably generated. But, unfortunately, we know too little of these processes, and of means which may influence them, to enable us to fulfil this indication with effect. A gouty constitution, in the absence of the febrile paroxysm, is often much improved by the use of bitters and other mild tonics; and in diabetes, an amendment occasionally takes place during the exhibition of opium and some of the stronger astringents and tonics, such as preparations of iron, copper, &c.

In the effect which each exerts on the economy, there is a great difference between the morbid matter of gout and that of diabetes. The sugar in the latter has no tendency to accumulate in the system, and produce local effects; but, acting as a powerful diuretic, it passes rapidly away, carrying with it a great quantity of water and of the other constituents of ordinary urine, (§ 165;) and the thirst, dry skin, and emaciation of diabetes, seem to be chiefly due to this mode of operation. The common complication of diabetes with pulmonary consumption shows also, however, that the plastic process is degraded, (§ 211.)

The lithic acid of gout and gravel, on the other hand, has a tendency to accumulate in the body, and to cause the local and general irritations which have been already mentioned, (§ 254.) Hence it becomes a chief indication to counteract its irritating properties, and to promote its elimination from the system. The medicines which are most efficacious in doing this are alkalies, or their carbonates, or their vegetable salts, with colchicum, or iodide of potassium, saline mineral waters, and alterative aperients. These increase the action of the kidneys and intestinal canal, and drain off the offending matter from the system.

257. It is supposed by most chemists, that the urea excreted by the kidneys is chiefly derived from the transformation or decay of the textures of the body, (§ 254,) most of their carbonaceous matter being abstracted by the affinity of the oxygen of the blood, and carried off by the lungs in the form of carbonic acid gas, (§ 232.) The causes which increase the production of urea are, according to Liebig, those which excite the activity of the function of respiration, which supplies the consuming oxygen, especially active bodily exercise. Under some circumstances, however,

the formation and excretion of urea is much augmented, without any obvious excitement of the respiratory function. This is the case in the diabetes ureosus described by Dr. Prout, and which he considers a forerunner of saccharine diabetes. Such spontaneous production of the matter, which seems to be a kind of debris of the body, indicates organic weakness, and has been observed to occur in young persons who have grown rapidly, and in those weakened by venereal excesses. An excessive excretion of urea (or of carbonate of ammonia, which is of kindred composition,) sometimes takes place in typhoid fevers, and is attended with great loss of flesh and strength. A great and sudden increaseof urea in the urine was ascertained to have taken place, in some patients, with acute rheumatism, in University College Hospital, at the decline of the fever and other symptoms. This perhaps ought to be viewed as arising from the removal of that which had accumulated rather than from an increased formation of urea; and this fact may be connected with that ascertained by Professor Chelius and Dr. Lewins, that colchicum causes an augmented discharge of this and other principles of the urine, (§ 252, 173.)

In cases of excessive formation of urea, all circumstances which depress or exhaust the organic life must be avoided, such as great excitement of body or mind; waste must be supplied by a generous diet, and the nutritive function sustained by tonics. Opium and other narcotics are found to be useful in reducing the urine in the diabetes ureosus; and it is not improbable that their operation is directly on the vital part of the process of transformation of the textures, as much as on the respiration.

SECTION XVI.

CHANGED PROPERTIES OF THE BLOOD FROM THE PRESENCE OF FOREIGN MATTERS.

258. The blood is probably the chief seat of the morbid poisons which excite various contagious, (§ 93,) epidemic, (§ 88,) and endemic diseases, (§ 81.) Probably, too, it is the hot-bed in which some of them are propagated, (§ 99,) and it is through changes in its composition that many of the destructive effects of these poisons are produced, (§186, 196.) We have already noticed some of these changes under former heads. It will suffice in this place to mention a few examples in which morbid poisons have been traced to the blood.

Dr. Francis Home communicated measles from one person to another by inoculating with the blood of a patient affected with the disease. M. Gendrin describes the following experiment:—

A man who had been skinning a diseased animal was seized with a putrid fever, attended with an eruption of sloughing pustules. Some blood taken from this man was injected into the cellular texture of the groin of a cat; the animal was soon affected with vomiting of bile, dyspnœa, frequent small and irregular pulse, dry brown tongue, slight convulsions, and died seven hours after the injection. The same pathologist produced in animals various severe symptoms, speedily ending in death, by injecting into their veins blood from a person labouring under confluent small-pox. MM. Dupuy and Leuret communicated to a healthy horse the malignant pustular disease called "charbon," by injecting into its veins blood from a diseased animal. [From the experiments of M. Renault it would seem certain that the blood is essentially diseased in glanders. By injecting the blood of a horse labouring under glanders into the veins of a healthy horse, he was enabled to communicate the disease.—C.] Andral quotes from Duhamel an extraordinary case, in which blistering, pustules, malignant fever, and death, followed the mere contact on the lips of the diseased blood of an animal. Other instances are on record of sickness, faintness, and serious illness being caused by the odour of blood; and Dr. Copland tells a marvellous story of three persons being struck dead by the smell of the blood in the plague.

259. There is good reason to suppose that purulent matter, and the germs (§ 90) of carcinoma, and other forms of malignant disease, are spread through the system through the medium of the blood. The tendency to symmetrical arrangement which cutaneous eruptions, nodosities of the joints, paralysis from lead, and some other local affections exhibit, has been adduced by Dr. W. Budd and others, as an instance of effects produced through the medium of the blood—the symmetrical distribution of this fluid on the opposite halves of the body leading to like results in corresponding parts.

260. In the *treatment* of this element of disease, *foreign morbific matters in the blood*, the two indications which present themselves are—1. To counteract the injurious operation of these matters; and, 2, To expel them from the system. The first of these indications is followed, when we give stimulants to overcome the depressing influence of adynamic fevers and other sedative poisons; and when opium and other narcotics are administered where irritation prevails. We do not possess chemical antidotes which can act on the foreign matter in the blood without injuring the blood itself. The other indication is more generally pursued, although little recognized by practitioners,—to expel the offending matter from the system. The excretory organs, especially the kidneys and alimentary canal, are the

natural emunctories through which foreign and offending matters are expelled from the blood; and hence the utility of alterative aperients and diuretics, (§ 173, 174,) in the treatment of fever and other diseases connected with poison or injurious matter in the blood. Orfila found that the pernicious effects of small repeated doses of arsenic in animals might be averted by giving at the same time a diuretic medicine. Let us bear in mind how often fevers and other serious ailments seem to be carried off by spontaneous diarrhœa, diuresis, or perspiration; and, perhaps, sometimes by these discharges artificially excited. Nor should a converse fact be overlooked, that persons affected with disease of the kidney, (cacoplastic degeneration,) which impairs its excernent function, are peculiarly liable to contract infectious diseases, and to suffer from their effects, (§ 17, 26, 32.)

CHAPTER III.

SECONDARY OR PROXIMATE ELEMENTS OF DISEASE, CONSISTING OF TWO OR MORE PRIMARY ELEMENTS, (§ 304.)

SECTION I.

ANÆMIA.

261. The class of *proximate* elements which have been most generally studied as the subjects of general pathology, are those affecting the circulation of the blood. They comprise at least three of the *primary* elements which have been considered—the blood and its constituents, and the moving and tonic fibre, (§ 110, 120,) concerned in its distribution. A previous acquaintance with these elements will render very intelligible many of the kinds and phenomena of their compounds, but it is necessary to keep in view also the physical properties of the vessels and their contents; for these properties, when altered, become elements of disease. Thus a mechanical obstruction or an enlargement of a blood-vessel contributes to the formation of disease as much as a change of vital properties. So it is impossible to understand the effects of too much or too little blood in the vessels, without a due consideration of the mechanical qualities of these vessels.

We shall briefly consider the morbid conditions connected with *defect* and *excess of blood* in the vessels, under the divisions of *general* and *partial*, and as attended with an *increase* or *diminution* of the irritability and tone of the moving fibre. It is to be understood that all the proximate elements of disease now to be considered, may occur either as distinct affections or in combination with other maladies.

262. *Anæmia*, or as it has been more correctly termed, *hypæmia*, or *oligæmia*, is the name applied to that condition of the system in which the predominant character is a *deficiency of blood*. It is often symptomatic of various maladies, particularly chronic and cachectic affections; but it sometimes occurs without

any other known disease, and its symptoms exemplify in a striking manner the mode in which the various functions suffer for want of a due supply of the vivifying fluid, (§ 183, 185.)

Thus the general symptoms of anæmia are those of weakness, (§ 116;) general muscular weakness, evinced by the faintness, breathlessness, and fatigue caused by exercise; weakness of the heart, shown by the feeble, loose, or thready pulse, rendered very frequent and palpitating by slight exertion, and often irregular and failing afterwards; feebleness of the whole circulation, (§ 123,) manifest in the coldness of the extremities; organic weakness, shown by the loss of appetite, indigestion, torpor of the bowels, scanty and disordered secretions, (§ 172;) defective nutrition, (§ 211,) especially of the muscular parts; and imperfect sanguification, for the remaining blood becomes diseased, being poor and watery, as well as scanty, (§ 185, 222.)

263. There are also distinctive physical signs of the scantiness of blood in the body: the surface is remarkably pallid, and even the lips, gums, and tongue, show none of their healthy ruddiness. The complexion may vary the amount and kind of the paleness, dark persons often appearing very sallow, or even of a yellowish or greenish tint, (whence the term chlorosis,) and those of fair complexion having a ghostly paleness. If blood-vessels are seen at all, it is only the larger superficial veins, which are pink instead of blue, from the paucity and transparency of the blood in them. In the course of the larger veins, especially the jugulars in the neck, the thin blood, running with great rapidity in the ill-filled vessels, is often thrown into sonorous vibrations, (venous murmurs,) which are sometimes sensible to the finger placed lightly on the vein. The same thinness of the blood, together with an abruptness in the heart's contractions, (§ 113,) frequently causes a murmur with the first sound of the heart, referable to the aortic orifice: as, however, this murmur varies much in different cases, being scarcely audible in some, whilst it is loud and harsh in others, it is obviously dependent in part on some irregularity or narrowing at the mouth of the aorta, too trifling to give any obstruction or sound when the blood is abundant and of due spissitude, but readily causing vibrations and sonorous gushes when the fluid is thin and the relations between the size of the heart and arteries somewhat changed.

264. The blood, when drawn, is very thin and watery. It readily coagulates, and forms a very small contracted clot, (§ 207,) generally covered with a buffy coat. This appearance is probably due, as Andral surmises, to a predominance of the fibrin over the red particles, for these are diminished much more than the fibrin, being in extreme cases nearly reduced to one-fifth of their natural proportion, (§ 185.) The albumen is also often

scantier than usual; but from the researches of Andral and Delafond on sheep, it is probable that it is not so in all cases, but chiefly in those attended with dropsy, (§ 222.)

265. Although the symptoms of anæmia are chiefly those of great weakness or depression, (§ 262,) there are often others of an opposite character, indicating irritation or exaltation of function. Some of these arise indirectly from the weakness, as for example, pain, nausea, colic, and diarrhœa, (§ 56, 168, &c.,) which may be traced to the weak digestion leading to the production of sundry irritating matters from that which has been used for nourishment. But other more direct signs of excitement sometimes occur. Thus various properties of the nervous system are sometimes exalted; sensibility is acute, (§ 126;) there is intolerance of light and sound, with flashes in the eyes, noise in the ears, a sense of rushing in the head, and various neuralgic pains. The excitomotory nerves are sometimes excited, (§ 140, 150,) and spasms or convulsive affections of different kinds may be present, or the organic functions may be affected, and palpitation, spasmodic asthma, vomiting, and such sympathetic irritations, may occur. In a few instances, anæmia has been attended with delirium, or mental excitement bordering on it.

266. It thus appears that the functions which sometimes are excited in the midst of general depression and weakness, are those of the nervous centres; and the generally nervous character of persons in a state of great weakness (§ 113) is connected with the same fact. No explanation of this apparent anomaly has been to my knowledge proposed; but one seems to suggest itself in the peculiar distribution of the circulation through the nervous centres. When the mass of the blood is reduced in quantity, the blood-vessels generally contract in proportion, their tonicity adapting them to the amount of their contents, (§ 120.) But the vessels within the skull and spinal canal cannot contract with the same facility, for not being exposed to atmospheric pressure, and some of them being fixed in bony canals, they do not shrink as the blood becomes reduced, and therefore they retain more than their proper share of the circulating fluid.* This disproportionate amount of blood in the nervous centres produces different effects, according to the degree in which the heart's propulsive power (§ 111) reaches it. Under the influence of palpitation, (§ 112,) fever, or other kind of excitement, the brain and spinal

* This statement is not invalidated by the recent experiments of Dr. G. Burrows. (Med. Gaz., April, 1843.) His experiments and expositions very satisfactorily demonstrate the absurdity of the notions, founded on Dr. Kellie's paper, that the quantity of blood in the head is always the same; but it remains clear that the circulation within the head and spinal canal, especially in man, is affected by losses of blood, differently from the circulation in other parts.

cord receive through their uncontracted vessels an unusual share of the force from the heart; an erethism of some one or other of the functions of these nervous centres (§ 127, 153, 133,) is the consequence; and pain, spasm, sensorial disturbance, or sympathetic irritations of some kind or another, occur.*

267. On the other hand, if the heart's action is feeble, (§ 116,) it may be inadequate to propel the blood accumulated in the vessels of the brain; it therefore stagnates, and may cause some of the symptoms of congestion in that organ. Hence headache and giddiness, relieved by the recumbent posture, drowsiness, impaired mental faculties, partial paralysis, and, in extreme cases, coma or catalepsy, (§ 129, 133, 141.) In such cases the blood is accumulated more in the veins and sinuses of the brain than in its arteries, and is not moved in proportion to its quantity. This congestion may be only temporary, and lead to no serious results; but in some cases I believe there occurs an event that has not been noticed by pathologists—namely, a coagulation of the blood in the sinuses, and a consequent permanent obstruction to the passage of the blood through the brain. I have met with at least three cases of the following description.

A young female becomes anæmic, and after exhibiting various symptoms of feeble general circulation, with headache, drowsiness, and impaired sensorial functions, suddenly becomes worse; passes into a state of stupor with dilated pupils, sometimes varied by slight manifestations of delirium, throbbing of the carotids, and partial heat of the head, and dies comatose. On opening the head, a small quantity of serum is found under the arachnoid and in the ventricles, sometimes with a little lymph, (in one case there was none.) The vascularity of the membranes is remarkable, but the vessels most distended are the veins, and in the larger of these and in the longitudinal sinus, there is a firm coagulum. In parts, especially at the torcular Herophili, this coagulum blocks the whole sinus, and exhibits a separation of fibrin, portions of which are softened down into that purilaginous matter which was long mistaken for pus, but which Mr. Gulliver has shown to be a physical change of the fibrin which mere stagna-

* Although the chief effect of excitement of the circulation in anæmia is thus directed to the nervous centres, it is by no means confined to them. Other parts in the immediate vicinity of the heart become the seat of increased arterial pulsation and disturbance. Thus a painful throbbing is often complained of in the throat, chest, and epigastrium, even when there is little pulse in distant arteries, and the extremities are cold. To understand these facts, we must bear in mind that when the arteries are full and tense, they oppose their fulness and tension to each contraction of the heart, which resistance reduces the strength of each pulse in the vicinity of the heart, although it contributes to propagate it to a distance; but when the arteries are empty and loose, the heart squirts into them the blood in an unresisted jet, the force of which is strong near the heart, but extends not to distant arteries.

tion may effect. These have been taken for cases of meningitis. No doubt inflammation does supervene in them occasionally, but in two cases that have fallen under my notice, there was no adhesion of the arachnoid nor deposit upon it, nor any other unequivocal mark of inflammatory action; yet the fibrinous and bloody concretions in the veins and sinuses were most remarkable for their size and firmness,* (§ 213.)

It appears to me most probable that these affections originate in the encephalic congestion connected with anæmia. Fibrinous concretions form on the transverse bands of the sinuses, and increase until they considerably obstruct the passage of the blood: hence the impaired state of the cerebral functions, amounting at last to coma. Reaction (§ 16) may take place, with determination of blood, and even inflammation, and these cause those symptoms of partial excitement that sometimes exhibit themselves; but neither during life, nor on examination after death, are the proofs of excitement so prominent as those of obstruction and interruption to the cerebral functions. It must be remembered that in anæmia the fibrin of the blood is not diminished in the proportion of the other animal contents, and it has a greater tendency to coagulate than in healthy blood, (§ 207.)

268. In anæmia of long duration the process of nutrition often suffers, (§ 211,) but by no means uniformly. The cornea sometimes becomes ulcerated; probably because, being a non-vascular texture, it the more needs a nourishing quality of the plasma. The muscles become flabby and attenuated; wounds and fractures sometimes do not readily unite; and in some instances spreading ulcers and sloughy sores form spontaneously on the surface. Emaciation is by no means a constant result of anæmia; and it is not uncommon to see the most pallid subjects, especially females, retain a considerable amount of fat. Dropsical effusion into the cellular texture is a common result of anæmia when either long continued, or aggravated by additional causes which disturb the circulation, (§ 222.)

269. The exciting causes of anæmia are, various circumstances which withdraw blood, (§ 71,) or interfere with its formation, (§ 66;) excessive bleedings, or hæmorrhages; profuse evacuations of other fluids which contain much of the animal parts of the blood; scanty or poor food, especially that which contains little animal matter or gluten; confinement in impure air, dark places, or malarious districts; certain chronic maladies which

* A wax model of the sinuses and membranes in one of these cases is in the museum at the University College. Cruveilhier gives a representation of a similar case, which, without sufficient reason, he considers as one of cerebral phlebitis. Andral mentions a case of cerebral hæmorrhage in connection with anæmia, which was probably of the same kind.

deeply affect the constitution, such as tuberculous and cancerous diseases, and granular degeneration of the kidneys, (§ 185, 222, 249;) but the commonest cause of all is irregularity of the uterine function. It is difficult to understand how the last operates; but that in many cases it is a cause and not an effect of anæmia, is plain from the well known fact that no signs of anæmia have occurred until cold, over-exertion, or excitement, or some circumstance, has suddenly checked the flow of the catamenia; it has not returned, and then the patient begins to lose colour, and gradually to exhibit the anæmic state. In many cases I have known this occur in young females who have previously suffered from acute rheumatism, implicating the heart. It would seem that in these cases some injury is done to the bloodmaking process; but what, or where, must remain obscure until we know something more about the seat and nature of that process. In some of these cases of chlorosis, the appetite is depraved, (§ 131;) there is such a complete disrelish for animal food and other nourishing articles, and such a craving for sour things, and even for matters destitute of nourishment, as chalk, cinders, &c., that it might be supposed that this perverted appetite is the cause of the anæmia by deterring the patient from taking that food which is capable of making red blood; and undoubtedly such an appetite, when indulged, must contribute to this result; but it is not so constantly present as to be considered the only cause of the anæmia in the examples under consideration.

270. Anæmia, in its extreme degrees, may prove fatal suddenly by syncope, (§ 71,) brought on by exertion or any additional cause of exhaustion; or more gradually, by asthenia, or general failure of the vital powers, often attended with anasarca; or by developing tuberculous (§ 211) or other cachectic diseases to which the individual may be predisposed; or by the singular affection of the head before noticed, (§ 267.)

[The fundamental and constant character of anæmia is the diminution in the red-corpuscles of the blood. Women are more subject to it than men, although these may be attacked with spontaneous anæmia at all ages. The clot is small, but firm and dense, swims in a large quantity of colourless serum, and presents on its surface a well-marked buffy coat, which however differs from the buff of inflammatory blood by a gradual termination in the red-mass, and not by an abrupt, well-defined line. (This is due to the excess of fibrin relatively to the globules.) When the red-corpuscles are below 80, according to Andral, the bruit de soufflet in the arteries is a constant phenomenon. It is often heard when their cypher oscillates between 80 and 100, and becomes more rare as the physiological mean is approached, and when it is reached, ceases altogether. Whatever other disease, besides anæmia, in which this diminution of the red-corpuscles exists, we have this phenomenon; in putrid and eruptive fevers, pneumonias, acute articular rheumatism, and in a great variety of chronic diseases. The bruit de soufflet is often present in pregnant women, and corresponds with the frequent diminution of the red globules in them.

In spontaneous anæmia the red-corpuscles, alone are affected, the other sanguine elements remaining intact; subsequently, however, they may become likewise compromised.—C.]

271. *Remedial measures.*—Most of the measures useful for the treatment of anæmia have been already described as those suitable to restore a deficiency of red particles and fibro-albumen, (§ 193, 216.) A nourishing diet, with as much animal food as the digestive powers of the patient can master—tonics that best restore the appetite, the powers of digestion, and sanguification—the use of means, if necessary, to promote the natural excretions, (§ 172 *et seq.*,) and an exposure of the patient to the pure air and light of heaven, as free as the strength and sensibility will bear—form the chief items of the treatment.

The adaptation of this treatment to particular cases will require much discretion, especially in proportioning the food to the faculty of digestion, and in selecting a tonic that shall not irritate. Where it does not disagree, iron, in some of its forms, is unquestionably the best tonic; and in many comparative trials, I have found the iodide of iron (in solution with syrup) the most speedily efficacious. Besides its tonic action, it promotes the secretions more than other preparations of iron; and by its use I have seen females restored from extreme pallidity to a rosy hue of health, in less than three weeks. The sesquioxyde, citrate, tartrate, lactate, and ammonio-chloride, are more tardy in their operation; and the sulphate and sesquichloride are apt to nauseate, or otherwise disagree; but each is found occasionally useful, and so are chalybeate mineral waters. In some cases any preparation of iron causes headache, fever, sickness, or some other symptoms of disorder; and then milder tonics, as calumbo or other bitters, with mineral acids, or with iodide of potassium, are more suitable at first; and the stronger tonics, with iron, may be given afterwards. In extreme cases, as those after excessive losses of blood, I have found it very useful to give sulphate of quinine at the same time as the iodide, or some preparation of iron.

The success of the treatment becomes manifest, not only in the return of a healthy colour to the lips and skin, size to the superficial vessels, and strength to the pulse, but also by an improvement in all the functions, breath, strength, digestion, &c. It is a curious fact that the venous murmurs, (§ 263,) although diminished, are not so in proportion to the apparent return to health.

272. Besides these general measures, indicated for all varieties of anæmia, particular cases require temporary measures, on the one hand, to prevent faintness or excess of weakness, (§ 262;) on the other, to subdue nervous excitement, (§ 265,) and counteract the congestion in the head, which we have found to occur, (§ 267.) Diffusible stimulants, such as carbonate of ammonia, valerian, æther, wine, and spirits, are often useful as temporary means of obviating the extreme weakness. Nervous symptoms may be treated by various narcotics, such as hyoscyamus, conium, opium, &c. But, inasmuch as these very symptoms seem to depend on the irregular distribution of the little blood left in the body, they will be the most effectually relieved by reducing this irregularity, by warmth and friction to the surface and extremities, rest in the horizontal posture, varied with such gentle exercise as the patient can bear, with pure air, and the judicious use of tepid or cold sponging, or shower-bath, (§ 124.) The symptoms of decided cerebral congestion and obstruction have generally been treated by antiphlogistic remedies, but with questionable advantage. I should expect more benefit from a mild stimulant plan, together with derivants, purgatives and diuretics. Such a plan commonly answers best in the congestive headache, which often troubles anæmic subjects.

PARTIAL ANÆMIA.

273. We have the means of studying defect of blood in a part of the body in more diversified degrees than defect in the whole; and the result we find to be an impaired state of the functions in every degree, from that of mere weakness to that of total suspension and death. Thus temporary pressure on the chief artery of a limb soon causes numbness, weakness, and reduction of temperature. The same effects result in a more marked degree from the ligature of an artery in cases of aneurism, and are gradually removed as the supply of blood is restored through collateral arteries. In some such cases, the supply of blood is insufficient to maintain the vital properties of the part; then chemical affinities prevail, (§ 50,) decomposition ensues, and the part becomes gangrenous and dies. A similar result ensues when the arteries of a limb become obstructed by ossification and coagulation, as in senile gangrene. This event may be produced artificially in animals in forty-eight hours, by injecting charcoal powder into the artery of a limb, which totally obstructs its capillaries. (Majendie.) It is, most probably, by obstructing the circulation, and thus depriving the parts of an element indispensable for the maintenance of their life, that inflammation and other lesions sometimes terminate in gangrene.

Softening and wasting of textures are also effects attributable to continued defective supply of blood. The former is exemplified in softening of the brain and of the heart in connection with ossified arteries: the latter in the wasting of parts subjected to continued pressure. Hence partial anæmia is concerned in producing many changes of structure arising under various circumstances. Deficient supply to secreting organs necessarily impairs the amount and quality of their secretions, (§ 159.)

SECTION II.

HYPERÆMIA OR POLYÆMIA, EXCESS OF BLOOD.

274. *Too much blood in the system*, or *in a part*, is a most frequent element of disease. It implies an undue distension of the vessels which contain it; and a modification of the properties of these, and of the heart which propels it, is almost constantly a concomitant of this morbid condition. The chief vital properties of the heart and vessels are irritability and tonicity; excess (§ 114, 121) and defect (§ 116, 123) of these form most important elements, which modify the effects of excess of blood; and thus is suggested synthetically a division (long recognized as most important in practice) into active or sthenic, and passive or asthenic hyperæmia; which distinction is applicable to both the general and the partial excess of blood. Another variety of hyperæmia may be distinguished by an altered or perverted action of the vessels, which is chiefly applicable to the affection in a part, and includes that singular and complex condition—*inflammation.* A view of these important proximate elements of disease (§ 107) is given in the following table:—It is not meant that the diseased conditions here specified are always separate, or that they consist merely of the elements here stated; but these are their most distinguishing parts, and most important in regard to treatment.

			RESULTS.
HYPERÆMIA: excess of blood	General=Plethora	with motion increased=Sthenic	Hæmorrhage.
		— — diminished=Asthenic	Flux.
	Local	with motion diminished=Congestion	Dropsy, &c.
		— — increased=Determination of blood	
		— — partly increased,	
		— — partly diminished=Inflammation.	

SECTION III.

PLETHORA—GENERAL EXCESS OF BLOOD.

275. As general anæmia may arise from defective formation or excessive expenditure of blood, so general plethora may proceed either from too much blood being made, or from too little being expended. In either case, the blood accumulates and fills the heart and blood-vessels beyond the usual degree. But this implies a certain activity and health in the processes of digestion and assimilation, and also a freedom from any considerable local disorder. A person with weak digestion rarely becomes plethoric; and one who suffers from a local ailment is commonly warned by an aggravation of this, before the fulness can become general.

276. The persons who become plethoric are rather those overflowing with health, who have a good appetite, and indulge it, without sufficient regard to exercise and to the excernent functions. The blood-vessels becoming more and more filled, the signs of plethora appear in the red face, distended veins, and full pulse; the heart labours with its load, especially on exertion; palpitation and short breath may ensue, with somnolency and indisposition to exertion; but these may attract no further notice than to induce the abandonment of exercise. The state of plethora, thus gradually induced, may be extreme, without any functions materially failing, and yet the subject is on the brink of various maladies. It is well if a great secreting organ is first excited under the high pressure, and relieves the system through a free discharge, as by mucous or bilious diarrhœa; by bleeding piles, &c.; or one of these secreting organs may fail in its proper function, (§ 170, 254,) as the liver or the kidneys; and a bilious attack, jaundice, or a fit of gout or gravel, is the consequence. Any of these, by establishing a perceptible ailment, disturbs the dangerous ease of the plethoric; and by rendering necessary a temporary discipline, saves him from the worse results of plethora—apoplexy, structural disease of the heart, great vessels, kidneys, or liver.

278. Besides the causes already noticed, other circumstances may induce plethora. The diminution of an habitual excretion or loss of blood, the drying up of a long established sore or issue, (§ 270,) or the removal of a limb; all of which diminish the expenditure from the system, without impairing the blood-making process, often become causes of plethora, if no local disorder be excited before the vessels in general reach a plethoric tension.

279. The division of plethora into *sthenic* and *asthenic* arises from different proportions of the strength and irritability of the moving fibre, which we have noticed as ultimate elements of disease, (§ 110 and 120, *et. seq.*) Where the irritability and tone of the heart and arteries are in full amount, the increased quantity of blood excites these properties to full operation. Short of disease, the functions are active and energetic in proportion to the quantity of blood which their organs receive; the heart's action and the arterial pulse are strong and regular; secretions are abundant, sensibility is keen, contractility powerful and in good tone, animal heat is sustained, and the mental and bodily powers generally are great and active. But beyond this, plethora tends to disease: the heart's action is over-excited; the pulse is frequent, as well as strong and hard; the face is florid and flushed, and the heat is almost feverish; the capillaries of secreting organs and surfaces are variously disordered; sometimes excited to excessive secretion, sometimes beyond it, to a state of fulness bordering on hæmorrhage or inflammation; sensibility and sensorial powers may be over-excited by the rapid flow, or oppressed by the pressure of the blood on the nervous centres. If the plethoric state is moderate enough to last for some time without immediate disaster, the nutritive function will eventually be affected—the heart and vessels, and more vascular textures, being the earliest to exhibit an increased growth, often with some change of properties. Thus may originate structural disease, from the continued excitement of sthenic plethora.

280. Sthenic plethora is that which commonly affects the young, the active, and those of sanguine temperament, (§ 41.) It comprehends a rich state of the blood, (§ 184,) and an active condition of the nutrient function, (§ 195.) Its tendency is to cause general febrile excitement, active hæmorrhages, fluxes, and inflammations.

281. In *asthenic* plethora, there is a want of contractility (§ 116) and tone (§ 123) in the moving fibre. The heart and other organs, instead of being excited by the augmented quantity of blood, are oppressed by its load. The pulse may be full, but it is slow; sometimes irregular or unequal. There is sometimes a tendency to faintness alternating with palpitation; physical examination shows the heart to be enlarged by the accumulation of its contents, which it cannot expel. The face is purple rather than red; the veins are generally distended; sometimes the extremities are apt to become cold. Other functions are sluggish, and imperfectly or irregularly carried on. The bowels are torpid, the urine high coloured or turbid, sensibility is blunted, and the mental faculties dull, with lethargy or somnolency.

Asthenic plethora affects especially those weakened by age, excesses, or previous disease, and those in whom the excreting organs act imperfectly; which imperfect action is a cause, as well as a consequence of plethora. Asthenic plethora tends to produce congestions and passive hæmorrhages, and fluxes or dropsies; and if continued, structural changes in some organs, as dilatation of the heart, enlarged liver, varicose veins, &c. Congestion of the brain, with apoplexy or palsy, headache, or other symptoms of disturbed function, sometimes is produced; or if there be any organ, the vessels of which, from past or present causes, (§ 31, 32,) are weak, this organ may be the first to suffer.

282. The symptoms of asthenic plethora hitherto described are chiefly those of a depressed or oppressed state of the functions. Sometimes, however, there arise others betokening excitement or reaction of an irregular kind. The pulse becomes quickened, and often irregular; the skin becomes hot, or partially perspiring; sickness and vomiting may occur; the tongue becomes much furred, and sometimes brown and dry; the excretions are unusually offensive, and often changed in appearance; the complexion becomes dusky, the eyes suffused, the mental faculties disturbed or impeded in delirium or sopor. This is a kind of congestive fever, described by Dr. Barlow as a result of reaction from asthenic plethora. It is probable that this description has been partly drawn from cases in which, besides asthenic plethora, some morbid poison (§ 258) has been in operation; but many of the symptoms here named may be fairly traced to a congestive fulness of the blood-vessels, with an impaired action of the excreting organs, (§ 70, 171, &c.;) and consequently, the diseased condition of the blood, which we have described to arise from imperfect excretion, (§ 248, *et seq.*) The process of reaction or febrile excitement, which occurs in cases of asthenic plethora, is sometimes more distinctly connected with the condition of the blood, as in the case of gout, (§ 254,) rheumatism, (§ 251,) and various cutaneous diseases, which become developed generally in the less inflammatory forms.

[In thirty-one individuals suffering from well marked plethora, the mean of the fibrin was 2·7, which is rather below the healthy standard. Plethoric persons are consequently not more liable to inflammatory diseases than others, and an appeal to clinical experience will sustain this assertion. The organic materials of the serum do not offer any remarkable alteration in proportion or composition in plethora. The blood of plethoric persons is very highly coloured. On coagulation the serum will be found more or less deeply tinged; the clot is larger, of moderate consistence, and contains a good deal of serum, and is never buffed. If the blood has flowed very rapidly from the vein, there is sometimes a thin, transparent pellicle on the surface.

In plethora all the organic functions are more actively performed. There is a remarkable disposition to exaltation in the cerebral functions; the emotions are frequent and very mobile, without however, those exaggerations and aberrations of sensibility, those nervous predominances, which almost constantly occur in anæmia. Plethoric persons are liable to certain accidents, as vertigo, dimness of vision, ringing in the ears, and heats in the head. These symptoms have been usually attributed to cerebral congestion, a condition which has, however, never been ascertained. Andral thinks these phenomena sufficiently accounted for by the passage of an increased quantity of red corpuscles through the vessels of the brain. It is strange that, as we have seen, (§ 264,) opposite conditions of the red corpuscles as regards quantity, produce analogous phenomena. Plethora predisposes to hæmorrhages. The bruit de soufflet never occurs in plethora, as has been erroneously stated.—C.]

283. *Remedial measures.*—The means already described as useful in reducing an excess of red particles (§ 192) and fibrin (§ 214,) are also applicable to the earlier and simpler states of plethora. In fact, in these states, the blood usually does exhibit this excess, for which blood-letting and other evacuants, and abstinence, are the chief remedies. The propriety of blood-letting in extreme degrees of plethora is evinced by the extent to which it may be carried without causing faintness. Thus Dr. M. Hall found, that from patients with congestive apoplexy, from forty to fifty ounces might be drawn without producing syncope; whilst in acute inflammation, the *tolerance* is usually less by about ten ounces. The beneficial effects of blood-letting are sometimes immediately manifest, although they are somewhat contrasted in the two varieties of the disease. In the *sthenic* kind, the pulse becomes softer, weaker, and less frequent; in the *asthenic*, it often improves in strength and regularity, and sometimes rises to a natural frequency. In simple and recent cases of both kinds, a sufficient blood-letting, with due avoidance of the causes of the plethora, (so far as that can be accomplished,) and the use of a little aperient medicine, may complete the cure.

284. But if the plethora have lasted long enough to produce some of its ulterior effects, (§ 282,) blood-letting may be an insufficient, nay, in some instances, it may be an unfit remedy. In both kinds of plethora, medicines which increase the secretions are generally indicated, and the diet must be much restricted; but the particular mode in which these ends are to be accomplished, varies greatly in the two forms which I have been careful to distinguish.

285. In *sthenic* plethora, not only the blood is in excess, but

also the irritability and tone of the moving fibre. Here, then, besides removing the excess of blood, sedative and relaxing remedies (§ 115, 122) are indicated. Antimonials, salines, digitalis, and hydrocyanic acid, and a cool regimen, we have found to answer this purpose; and these are often most useful in the treatment of sthenic plethora. The same remedies, with mercury, colchicum, and some others, fulfil also another indication, which may be presented, to augment excretions defective from an over-excited state of the capillary circulation, which borders on hæmorrhage or inflammation. If any part should especially suffer, local blood-letting may be requisite to prevent such a result.

286. In *asthenic* plethora of some duration, on the other hand, although blood-letting relieves them, it does not restore lost tone to the over-distended vessels. Tonics, (§ 124,) and even stimulants, (§ 119,) may be necessary at the very time that blood is drawn; and there may long be required such treatment as is calculated to restore the impaired functions of digestion and secretion, and to improve the depraved condition of the blood, (§ 174.) In such cases, the continued use of alterative aperients and diuretics, such as mild mercurials, with rhubarb, aloes, or senna, salines, and taraxacum, nitric acid, iodide of potassium, &c., may prepare the way for various tonics, such as calumbo, bark, and iron. In such cases, mineral waters, like those of Cheltenham, Harrowgate, and Llandridod, are often of great service; first the saline, which are aperient and diuretic, and afterwards the chalybeate, which, although tonic, usually contain enough saline matter to keep the secretions free. Some of the latter class, as the Bath waters, sometimes excite torpid and plethoric habits to a critical reaction, by bringing on a regular fit of gout, (§ 254.)

The diet, which should be very spare in sthenic plethora, must not be too much reduced in that of the asthenic kind. The food should be simple, but nourishing, and adapted to the power of digestion. Stimulant drinks are not generally necessary; but previous habits must be considered, and not suddenly reversed. Regular out-door exercise, as much as the strength will bear without causing excitement or exhaustion, is a most salutary part of the regimen.

SECTION IV.

LOCAL HYPERÆMIA. EXCESS OF BLOOD IN A PART.

I. WITH MOTION DIMINISHED—CONGESTION.

287. The true nature and distinctive characters of *congestion*

may be conveniently traced through its several causes, all of which agree in fulfilling the conditions here given as the definition of congestion, excess of blood in the vessels of a part, with diminished motion of that blood, (§ 274.) We have already found that parts of the vessels, and even the heart itself, become congested in asthenic plethora, (§ 281;) but this is as a part of a more general disease. We have now to consider the causes and phenomena of congestion of blood in a part, which may occur independently of general disease.

As the great source of the motion of the blood is the heart, and the distributors of that motion are the arteries, we may anticipate that a chief cause of diminished motion is a supply from the arteries insufficient to propel the blood in the capillaries and veins. Such an insufficiency occurs when, from whatever cause, the capillaries and veins of a part are enlarged, without a corresponding enlargement of the arteries leading to them. The reason of the diminished motion is thus easily found; but we have yet to inquire the cause of the other element of congestion, too much blood in the part.

288. Blood-vessels become congested, or unduly dilated, when their proper elasticity and tone are overcome; and this may happen when an obstruction in the veins prevents the free escape of blood from them, or it may happen from weakness of the coats of the vessels themselves, which yield to the pressure of the blood transmitted to them. The chief causes of congestion may be classed under these two heads:—1. *Those of venous obstruction;* and, 2, *Those of atony of the vessels,* (capillaries and veins.) Under these two heads we shall notice various cases of congestion, which will explain and practically illustrate the subject.

289. (1.) *Congestion from venous obstruction.*—When the arm is tied for venesection, the veins are compressed more than the arteries. Hence the veins swell, then the fingers become red, and after a few minutes purple, and the whole limb is swollen from the congestion of blood in its vessels. In like manner, congestions are caused in internal organs by an obstruction of the veins leading from them. Thus congestion of the brain may be produced by a tight cravat, (§ 51,) or by a tumour pressing on the jugular veins. Straining, (§ 64,) or holding the breath, and asthmatic affections, which impede the flow of blood through the lungs, cause congestions in various parts. Disease of the valves of the heart, which prevents the blood from passing onwards through it, produces fulness of the veins and of the capillaries in both the pulmonic and systemic circulation. Tubercles in the lungs cause congestion of these organs. Obstruction to

the transit of blood through the liver causes congestion in the abdomen, hæmorrhoids, &c. The characteristic of congestion beginning with the veins is, that the veins as well as the capillaries are distended; and this appearance is obvious during life in cases of aneurism or other tumour compressing the veins of the neck; and after death in the full arborescent appearance of the veins in the congested part. Certain diseases of the organs of respiration, especially extensive emphysema of the lungs, in which the efforts of expiration predominate over those of inspiration, cause congestions not merely by opposing the return of blood through the veins into the chest, but also by removing that suction influence which naturally much promotes the flow of blood in that direction at each inspiration. It has been pointed out by M. Berard, (Arch. Gen. de Med., Jan. 1830,) and by Mr. A. Shaw, (Med. Gaz., July, 1842,) that the circulation in the liver is, in health, much dependent on this influence; and it may be inferred that the diminution of this influence by extensive vesicular emphysema will assist in explaining why hepatic congestion is so commonly combined with this pulmonary lesion.

290. (2.) *Congestion from atony of the vessels.*—This comprehends a numerous class of cases. In some the atony of the vessels (§ 123) affects the whole system, as in case of extreme debility, adynamic fevers, and the sinking which precedes death. The blood thus accumulates in some of the vessels, chiefly those that are lowest in the position of the body; which in their weak state yield to the accumulating blood. This occurrence of the congestion in *undermost* parts (*hypostatic*) is the distinctive character of that of weakened vessels. Thus the posterior parts of the lungs, intestines, and integuments, are found much congested.

291. In other cases the weakness is local, without affecting the vessels generally, the weakening cause being applied to some vessels only. *Over-distension* is a common cause of congestive weakness of vessels. Thus from long continuance in one position, the lower vessels yield to the gravitating force, (§ 51,) of the blood, and become congested. This cause makes the feet swell after standing or walking long, especially in warm weather. A continued stooping posture, or lying with the head low, may occasion congestion of the brain, with headache, giddiness, confused vision, and may prove an exciting cause of apoplexy. Remaining long in a standing or sitting posture, often causes congestion in the hæmorrhoidal veins, liver, uterus, &c. Where the circulation is feeble, and the tone of the vessels weak, (§ 123,) these causes of congestion operate more readily and more permanently than where the circulation is vigorous; yet these con-

gestive affections, the result of weakness, are often mistaken for inflammations. Many of the pains and ailments of delicate females are of this nature; and although temporarily relieved by depletory measures, are to be permanently counteracted only by tonic means, (§ 124,) which promote the vigour and equality of the circulation.

It must be borne in mind that congestion, from mechanical causes, when it lasts long, may so weaken the vessels by over-distension, as to continue after their original cause has ceased to operate. Thus congestion of the brain or lungs induced by a paroxysm of dyspnœa, or coughing, or by violent straining, (§ 64,) may not subside with the cessation of the effort; giddiness, headache, pain, dyspnœa, &c., remaining for some time after.

292. In considering the operation of cold as a cause of disease, we found that it chiefly operates by constricting the vessels of the surface and extremities, and thus throwing the blood inwardly, causing internal congestions by intropulsion, (§ 77.) If this exists long, the tone of the internal vessels will be impaired, and the congestions will not cease on the restoration of warmth to the surface. Thus a permanent congestion in the lungs, liver, kidneys, mucous or serous membranes, whichever happens to be predisposed, may result; and this congestion may variously disorder the function of the part, or may lay the foundation for inflammation.

293. Malaria, (§ 82;) and the influences which produce continued and exanthematous fevers, (§ 93,) seem to have the same effect as external cold, but it is not so easy to explain how they operate. The cold stage of these diseases exhibits in a high degree the marks of intropulsive congestion; and it is well known that in ague the congestive enlargements of the liver and spleen are among its most remarkable phenomena. The congestions remaining during the febrile stages of fevers, seem to be the chief cause of their inflammatory complications.

294. Another cause of congestion is over-excitement of the vessels. It is well known that after a part has been inflamed, the vessels often remain dilated, but without the signs of inflammation. This is well seen in the conjunctiva, the throat, the skin, and in certain ulcers, and might be exemplified in some internal organs. The liver and stomach show many signs of congestion after the excitement of stimulant drinks, (§ 56.) But we may, under the microscope, trace the production of congestion apart from inflammation.

When a slight irritant, as a weak infusion of capsicum, is applied to the web of a frog, it first causes contraction of the vessels, especially the arteries, (§ 120,) then quickly follows enlargement of the arteries and other vessels with very rapid motion: after a while the vessels gradually contract and return to their natural size. But if the stimulant application be repeated several times, so as to prolong the determination of blood into the part, the vessels do not then uniformly contract. The arteries indeed shrink, but the capillaries and veins remain congested, and thus present completely the condition given in our definition, excess of blood with diminished motion, (§ 287.) This dilated state of the capillaries and veins must be chiefly ascribed to their losing tone after excitement, (§ 123,) more than the arteries; but the process which I have been describing is accompanied by changes also within the vessels; numerous lymph globules are formed and adhere to the sides of the small vessels, and contribute to impede the current and cause congestion by obstruction. Whenever the stimulus applied has been strong, this obstruction amounts to entire stagnation, and many vessels appear much enlarged, and filled with stagnant blood, or rather with an accumulation of red particles entangled in the coherent lymph globules. For this reason, the vessels in which the blood is stagnant, are of a deeper red than others, the red particles being arrested while the liquor sanguinis passes on.

295. All that has been now described belongs to congestion, and there can be little doubt that the intense and deep redness sometimes seen in congested parts, is partly made up of vessels in which the blood is absolutely stagnant. We shall find that a similar congestion and stagnation exists also in inflammation, and may be the only change left by it to be found after death, where the inflammation has not existed long enough to produce its more characteristic results. It is for this reason impossible to discern by anatomical characters between recent inflammation and some forms of congestion.

296. Besides, by its intropulsive mode of causing congestion, cold directly produces it by obstructing the capillary and venous circulation. This it does partly by its constricting influence, (§ 75,) which acts on the veins before it reaches the arteries, but from the experiments of Poiseuille it appears that cold physically impedes the passage of liquids through tubes, as he supposes by increasing their adhesive properties. From a few observations, I am disposed to consider that an increased production of lymph globules and their adhesion to the vessels operate here also.

297. Congestion occurs in various organs and surfaces when their proper secretions are arrested, or suddenly diminished, (§ 167.) It is difficult to determine whether the congestion is the effect or the cause of the defective secretion in the first instance; and very probably the relation is mutual: at least this is

the most convenient view to take of the matter for practical purposes. Thus means which increase the secretion, (§ 172,) will often remove the congestion; and those which relieve the congestion, generally restore the secretion.

298. There are some cases of congestion which have not hitherto been traced to any of the causes above specified, although it is not improbable that further investigation may refer them to some of these causes. It is well ascertained that when the blood does not undergo its proper changes in the lungs, (§ 234,) its passage through these organs is partially impeded, and it accumulates in the lungs, in the right side of the heart, and in the venous system generally. Congestions thus form a prominent part of the pathology of asphyxia. From the observations of Dr. John Reid, it appears that some obstruction also occurs to the passage of the blood through the systemic capillaries.

Again: in Mr. Blake's experiments, various saline solutions injected into the veins, (salts of soda, silver, &c.,) caused death by obstructing the passage of the blood through the lungs, without arresting the breath or coagulating the blood.

It remains for future observers to determine whether these obstructions may be connected with contraction of the vessels, (§ 120,) increased spissitude or cohesion of the blood, or other simply physical cause; or whether they depend on peculiar (vital) attractions and repulsions exerted between the vessel and its blood, which properties are supposed by some physiologists to constitute an important element in the healthy as well as in the morbid phenomena of the capillary circulation.*

* Whatever influence the vital properties of the blood may be supposed to exert in impeding the passage of the blood through the capillaries, I can see no reason for admitting that they in any degree contribute to its motion. That the power of the heart distributed by the arteries is sufficient to carry on the circulation, is apparent from several experiments, of which one by my colleague, Dr. Sharpey, is the most complete. A syringe, with a hæmadynamometer to show the amount of pressure used, was adapted to the aorta of a recently dead animal, the vena cava being divided. Warm water was then injected, and with a force that raised the mercury in the hæmadynamometer only three inches, the water passed through the capillaries and out of the vena cava. When the pressure was increased, so as to raise the mercury six inches, the flow was very free; and on adapting another hæmadynamometer to the vein, the pressure in this was found to rise as high as three inches. The pressure thus used in the arteries (six inches of mercury) was no greater than the natural pressure in the arteries of a living animal; and the pressure transmitted to the veins (three inches of mercury) was greater than that in the veins of a living animal, thus showing that the force of the heart, sustained by arterial tension, is quite adequate to effect the circulation without other aid.

The chief arguments for and against the existence of vital properties of attraction and repulsion at sensible distances, have been well stated by Professor Allen Thomson, in the article "circulation," in the Cyclopædia of Anatomy, to which I would particularly refer the student. In addition to these, I would state that in many long and careful microscopic examinations of the circulation in the frog's

299. We have considered atony of the small vessels (§ 290) as a chief cause of congestion: and it is so, not only by making them yield, and become distended by the accumulation of blood, but also by rendering them unfit to transmit the force of the current in its proper direction. Vessels which have lost their tone, become inelastic and tortuous, and by the very stagnancy of the blood in them, they oppose an increasing obstacle to its passage through them. The physical principle to which I now refer is not generally understood, and I will illustrate it by some experiments.

300. To one of Read's enema syringes, was adapted a tube with two arms: to one arm was fitted a brass tube two feet long, having several right angles in its course; to the other arm was tied a portion of rabbit's intestine, four feet long, and of calibre, (when distended with water,) double that of the brass tube. The intestine was placed in curves and coils, avoiding angles and crossings, which might obliterate the canal. The discharging end of both tubes was was raised to the same height, that of the intestine being kept open by a short tube of metal.

web, variously modified by different agents, I never witnessed any movement of the blood particles, which was not plainly referable to the action of the heart, or of vessels. The share which the arteries have in regulating the flow of blood through the capillaries and veins, is most evident. When the arteries increase in size, the flow becomes very rapid and general; when they diminish the flow is tardy, and even ceases in some capillaries; and when the arteries contract, so as to permit no blood to pass through them, the blood which still fills the capillaries and veins, becomes quite stagnant, without a sign of spontaneous movement. When motion begins again, it may always be traced to an artery, which first admits a file of single globules, which come few and far between, and in pulses; afterwards, as the artery enlarges, many rush in a continuous rapid stream, supplying proportionate motion to the vessels beyond.

Many of the instances of supposed vital motions in the blood, and other organic molecules, are referable to mere physical causes. Similar movements may be seen, quite as animated in appearance, on mixing under the microscope two drops of saline solutions of different strength or nature; any insoluble powder in these drops moves, as it were, spontaneously, and the motion continues until these drops have entirely pervaded each other. Still more lively motions are seen on adding any resinous tincture to water. Similar causes operate on blood molecules, giving them motions which appear to be spontaneous. But blood particles move also from another cause; they are not only carried by the current, but they are often changed in shape by it. Being vesicles, they swell or shrink by endosmose and exosmose, on any change in the density of the liquid in which they are conveyed; and these changes affect their position and form, their aggregation and separation, in a manner which might readily give the idea of their possessing spontaneous motions.

Although it seems unwarrantable to admit a self-motory power in the blood particles as *aiding* in the circulation, it is highly probable that changes in them, as well as in the vessels which convey them, may *impede* the circulation. The adhesion of the lymph-globules to the sides of the vessels and to each other, and, perhaps, the cohesion of the blood-discs, are changes likely to produce this effect; but it remains to be proved whether these operate in causing the obstructions of asphyxia, &c.

The tubes were then both filled by successive strokes of the piston; and when they both began to discharge, the quantity received from each in a given number of strokes, was ascertained. Without giving the details, it may be stated that the small metal tube discharged from two to five times the quantity discharged by the larger but membranous tube; the difference being greatest when the strokes of the piston were most forcible and sudden, by which the intestine, although much swelled at its syringe end at each stroke, conveyed comparatively little water. The difference was further increased by raising the discharging ends higher; and when both ends were raised to the height of eight or ten inches, the gut ceased to discharge, each stroke only moving the column of water in it, but this subsiding again without rising high enough to overflow. On increasing the force of the stroke, the part of the intestine nearest to the syringe, burst.

The experiment was repeated in various ways, of which I will mention one, with a metal tube two feet eight inches long, and a bore three-eighths of an inch, and a portion of dog's intestine of the same length, but when distended, of double the diameter. The metal tube yielded three times more liquid than the intestine.

301. These experiments show that flaccidity and increased length and size of a tube afford impediments to the passage of liquid through it; and although the experiments exaggerate the difference between healthy and relaxed or congested vessels, yet they really prove that the increased tortuosity and number of vessels in a congested part, the greater mass of their contents, and the atonic flaccidity of their coats, do truly form additional obstacles to the passage of the blood through them, although the amount of these obstacles will vary according to the state of the connected circulation.

These experiments illustrate a principle that is too little considered in animal and general physics; the *loss* or *neutralization* of *force, by misdirection.* The blood-vessels in their healthy condition are so constituted as to make the most of the heart's propulsive power and transfer it throughout their whole length; but when dilated, tortuous, flaccid, and otherwise altered, they misdirect and exhaust it: (as in the experiment with the intestine,) it is partly expended in distending and dilating the nearer portion, whilst a sufficiency does not remain for the onward propulsion of the blood, which therefore stagnates and accumulates in the congested vessels. We shall have many occasions to revert to this principle, which explains many anomalies of unequal circulation.

302. Without going so far as to say that atony of the capillaries is in this way the chief cause of the obstructed circulation in

asphyxia, (§ 298,) I think that it must be admitted as one cause, especially operating when the asphyxiating influence has been only a short time in operation. The free supply of air to the lungs may soon excite the capillaries to contract, and by restoring their natural tone and calibre, remove this cause of obstruction. If the congestion remain long, the obstruction is probably increased, not only by the more permanent loss of tone in the vessels, but also by changes in the blood itself, which render the removal of the congestion less easy and complete; and it is known that when asphyxiating causes have been long in operation, the congestions which they have produced are not dispersed by the restoration of the respiration.

THE SYMPTOMS AND EFFECTS OF CONGESTION.

303. When the arm is tied for venesection, the parts beyond the ligature become congested. At first the hand feels rather warmer than usual, and somewhat tender, from the distension of its vessels with warm blood, but it soon becomes numb, cold, and weak, showing that the want of circulation lowers its vital properties.

In like manner, simple congestion generally impairs the vital properties of internal organs, although the undue distension of their textures, by the increased mass of blood, may cause partial excitement. Natural contractility and sensibility are lowered, but pain (§ 126,) spasm, (§ 114,) and morbid sympathies, (§ 149,) are often excited, although in a manner much less distinct and constant than in inflammation or determination of blood. Thus congestion of the liver is sometimes accompanied by pain or tenderness; sometimes it is without either. Congestion of the stomach sometimes causes gastralgia, nausea, and vomiting, and altered appetite; but these symptoms are often absent when the amount of disease of the liver or heart, and the subsequent occurrence of hæmatemesis, leave no doubt that the stomach was congested. The same remark is applicable to the kidneys, the uterus, the brain, and other organs. We often see the tonsils and uvula congested and enlarged, without pain and soreness. Impaired nervous and muscular function is a more constant concomitant than pain, or any symptom of irritation.

304. The natural secretions of congested parts are sometimes at first augmented, as in congestion of the conjunctiva and schneiderian membrane from cold; but more generally they are diminished, as in bronchial congestion, (dry catarrh,) and congestion of the liver, kidneys, &c. But very commonly, congestion leads to an increased transudation from the whole distended capillaries, causing effusions of the watery and saline part of the

blood, more or less impregnated with albumen, and sometimes even with fibrin, as exemplified in the fluids of fluxes and dropsies.

The process by which this is the effect of congestion or secretion seems to be chiefly a physical one. The portions of the vascular apparatus most concerned in supplying the secreting structure, seem to be the middle parts of the capillaries, which are often so turned or convoluted, as to receive the most direct force of the current from the arteries. But when congested, the vessels leading to the middle capillaries become yielding, loose, and tortuous, and the force is much expended in dilating these before it can reach the secreting extremities:* the secreting portions are in the condition of the distant end of the intestine in the experiment above related, (§ 300,) not duly receiving the force of the current. Thus the more essential effect of congestion is to impair the natural secretion.

305. But the distension of the congested capillaries sometimes leads to a general exhalation of their more watery contents, which mingling with the natural secretion, render it watery and sometimes albuminous. Thus congestion of the bronchi sometimes ends with bronchorrhœa. Congestion of the intestines causes diarrhœa; congestion of the uterus, leucorrhœa; congestion of the kidneys, watery and sometimes albuminous urine; congestion of the lungs and pleura, hydrothorax; of the heart, hydropericardium; of the abdomen, ascites, &c.

306. The element of congestion chiefly concerned in the production of these effusions, is distension of the vessels. They are less commonly found, therefore, in mere hypostatic or gravitative congestions, (§ 291,) in which the distension is inconsiderable, but they more result from congestions from venous obstruction, (§ 289,) especially when these occur suddenly, whilst the vigour of the circulation is not impaired. Thus the congestions connected with diseased heart or liver, produced by acute attacks or other additional causes of obstruction, especially in plethoric subjects, if not soon removed, are pretty sure to end with dropsy,

* It may seem that this is taking too mechanical a view of the process of secretion: but be it remembered that I do not ascribe secretion wholly to mechanical agency, but only assert what is known to be a fact, that a due force of the capillary circulation is a condition favourable to this process. In lately inspecting the beautifully injected preparations of Mr. Dalrymple and Mr. Toynbee, I was particularly struck with the distribution of the capillaries of secreting surfaces, such as mucous and synovial membranes. These capillaries run pretty straight from the minute arteries, and end in loops and lampullæ on the surface, the returning vessels passing back as straightly. The physical effect of this provision is obviously to direct the chief force on the terminal loops which supply the secreting surface.

flux, hæmorrhage, or inflammation. The circumstances that determine which of these results shall ensue, will be considered when we come to these proximate elements of disease, but it may be mentioned that besides distension of the vessels, the condition of the blood considerably influences the result; a watery state promoting the transudation, (§ 222,) whilst a highly albuminous and fibrinous blood (§ 195) requires more pressure to make its watery parts pass through the coats of the congested vessels.

307. The same circumstances determine the character of the effused fluid. Where the blood is poor, the watery parts easily pass from congested vessels, even without much distension, and contain but little albumen. But if the blood abounds in the protein compounds, more pressure is required before much effusion takes place; and then, when the pressure is great, the fluid effused often contains, not only albumen in large proportion, but self-coagulating fibrin also, (§ 211.) Thus I have seen the fluid of the pleura and pericardium, in rapidly fatal obstructive mitral disease, coagulate spontaneously into a fibrinous crassamentum, when removed from the dead body. The gelatinous masses of lymph often found in the peritoneal sac of the abdomen and pelvis in ascites from contracted liver, I have no hesitation in referring to the same origin.

308. Fluxes arising from congestion of high tension exhibit an unusual amount of animal matter of an albuminous or mucous kind, as instanced in bronchorrhœa, mucous diarrhœa, and leucorrhœa. I have been almost induced to suppose that the polypous concretions and pseudo-membranous films occasionally effused on mucous surfaces may result from long continued congestion, with a highly fibrinous state of the blood, (§ 195.) I have seen these evacuated from the air-tubes, in one case, and, in another, from the intestines, from time to time, for months, and even years, without symptoms of inflammation, but under circumstances rendering it probable that congestion was present. Extensive disease of the heart existed in one case, and amenorrhœa in the other.

309. I have for several years referred albuminous urine (§ 249) to congestion of the kidney; and this view has been lately confirmed by some experiments by Mr. G. Robinson. The following considerations led me to entertain this opinion:—1. The urine often becomes albuminous during great embarrassment of the circulation in cases of organic disease of the heart, (§ 289,) when the kidneys are otherwise healthy. 2. I have, in a few instances, observed temporary albuminuria during the congestive stage of eruptive fevers. 3. In granular degeneration of the kidney, the amount of albumen in the urine is augmented by circumstances

causing congestion of the kidney, and is reduced by remedies suited to remove this. 4. Bright's disease of the kidney, in its earliest stage, presents the appearance of a highly congested structure, and is excited by causes calculated to produce congestion, such as frequent irritation of the kidneys by stimulating liquors—congestion from exhausted tone, (§ 294;) continued exposure to cold, especially after the kidneys have been thus excited —congestion from intropulsion, (§ 292:) scarlatina probably operates as the two last combined. 5. The albumen in the urine abounds most in the congestive (first) stage of Bright's disease —the vessels becoming more or less obliterated in the progress of the disease by a deposit of lymph (§ 307) in the cortical substance, and perhaps, especially in the corpora malpighiana— which deposit is, at the same time, the cause which perpetuates some degree of congestion, whilst it supersedes the proper secreting structure.*

310. From what has just been stated, it may be inferred that congestion, if continued, may affect the nutrition and structure of textures. It generally tends to cause an increased deposit in them, constituting a variety of *hypertrophy*. Thus, with diseases of the heart which cause congestion, there is an increase in the weight of the viscera generally, more particularly the lungs and liver. (Clendinning.) The enlargement of the liver and the spleen from long attacks of intermittent fever (called ague-cakes) may probably be referred to the congestion which this disease is known to induce, (§ 293.) I have known a similar enlargement of these organs to ensue after long continued exposure to cold and damp, (§ 77, 292.)

311. But the hypertrophy resulting from congestion is probably not of a uniform kind, comprising equal growth of all the textures; but, arising from an effusion of lymph from the most

* The secreting structure is partly diminished in another way also. The granular deposit presses not only on the blood-vessels, but on the uriniferous tubuli also; and wherever it totally obstructs them, their office ceases. These tubuli becoming distended, form the serous cysts so commonly found in granular kidneys, and sometimes in those which are not granular. But these cysts contain serum, or a gelatinous fluid, not urine; and this fact has been urged against the notion that they are dilated uriniferous tubes. The explanation, however, is not difficult. The secreting function of the kidney lies in nucleated cells lining the tubuli, (Bowman;) growing, filling, and bursting, as these cells do, by imbibition from adjoining vessels, this process, which is that of secretion, must be stopped when the cells are themselves pressed on by an accumulation of their own secretion, which cannot escape; but a serous exhalation from the blood-vessels still goes on, displacing by endosmosis the urine, and at last distending the duct into a cyst. The same explanation will apply to the serous cysts of the liver. This view explains how retention of urine or bile may lead to the suppression of the secreting power.

congested vessels, it is an intervascular deposit—at first mottling and exaggerating the appearance of the natural structure, as seen in the nutmeg liver and in the early soft stage of granular degeneration of the kidney—afterwards contracting and compressing the natural structure, and ultimately causing its condensation and atrophy, whilst the new deposit itself forms a granular or nodulated texture of low vitality, (§ 211.)

312. Such I believe to be the nature and origin of cirrhosis of the liver, and granular degeneration of the kidney. The varieties which these structural diseases present may often be traced to their degree of advancement, or to the extent to which they involve the structures; and an argument in favour of their origin in congestion may be found in the fact that they are commonly more advanced and extensive in the most dependent parts of the organs; as the lower margins of the liver, where congestion is most promoted, (§ 290.) It is highly probable, also, that these plastic products of congestion are, in some cases, more or less developed and further modified by determination of blood or inflammation, and by the composition of the blood itself.

Long continued congestion in the lungs may cause hypertrophy of the intervesicular and interlobular texture, and in some cases, partial consolidation of the vesicular structure itself. Such changes are frequently met with in connection with long standing disease of the heart, and abound most in the posterior parts of the lungs, and near their roots, the most vascular parts. In the membranes of the brain, and in the capsules of the heart, liver, and spleen, opaque thickening is often seen along the course of the blood-vessels, especially of the veins, apparently the result of the overflow of nutritive matter from these vessels.

REMEDIES FOR CONGESTION.

313. The most important means in the removal of congestion are those which contribute to the removal of their causes. Thus the loosening of a ligature, or the reduction of a tumour, compressing veins; the moderating the inordinate and inefficient action of a diseased heart; the restoration of the secretion of the liver, (§ 172,)—will severally tend to diminish the congestions resulting from these different venous obstructions.

314. So, also, in the treatment of congestion from atony or weakness of the capillaries, it is important to remove the circumstances which have caused this atony. In many cases it is over-distension from gravitation, (§ 296;) here change of posture gives relief. Thus, in congestive fevers, it is useful to change

from time to time the position of the patient. With congestion of the head, this part should be supported high. The recumbent posture gives much relief to congested hæmorrhoidal or uterine vessels, as we see it reduce the swelling of varicose limbs.

Pressure is sometimes a remedy for congestion, by supporting the weak vessels and promoting their contraction. This forms a chief part of the useful operation of bandages, adhesive plasters, and even of poultices, in various external congestions. It probably might be more extensively applied to these, and even to some internal congestions, in the modes suggested by Dr. Arnott, by mercury, or by the slack air-cushion.

Friction is a modification of pressure especially suitable to some forms of congestion, being calculated to give the motion that is defective, as well as to support the weak vessels. It is obviously useful in external congestions from cold; and sometimes in visceral congestions, as those of the liver and abdomen generally. Exercise operates somewhat in the same way.

315. Another class of remedies for congestion comprehends those which promote the contraction of the dilated vessels by augmenting their contractility or tone, (§ 124.) In this way astringents and cold operate; as in the use of solutions of alum, sulphates of zinc or copper, acetates of zinc or lead, and infusion or decoction of oak bark, catechu, kino, nutgalls, &c., in various congestions, particularly of the conjunctiva, throat, rectum, and vagina. The most obvious part of the action of bark, quinine, and arsenic, in the cure of ague, is in their reducing the great visceral congestions, which form their most remarkable, and perhaps their most important pathological element.

316. The utility of astringents in congestion is limited by the fact, visible under the microscope, that they commonly contract the arteries more in proportion than the capillaries and veins, which are most distended. Hence they may still further impair the motion of the blood, and increase the congestion. A reaction, however, sometimes occurs, which converts the operation of the astringent into that of a stimulant, which is another kind of remedy for congestion. The same remark is applicable to cold; and even more so, inasmuch as it also causes a physical obstruction to the flow of blood, in the manner formerly described, (§ 296.)

Stimulants sometimes are remarkably effectual in removing congestions. Thus diluted spirit to a congested conjunctiva, capsicum to a congested throat, a stimulating wash or ointment to a purple sore or surface, will often signally reduce the congestion. Other congestions are removed by exciting the circulation generally; a stimulant draught, or even one of any hot liquid, relieves the pulmonary congestion which has induced a fit of asthma; a congestive headache is sometimes mitigated by similar means. Well regulated exercise tends to disperse congestions in various parts. Various agents, which specifically excite particular organs or parts, (§ 173,) are often useful in removing congestions from them. Thus mercury is, in some cases, a remedy for a congested liver; some diuretics, as digitalis and cantharides for congested kidneys; squill, benzoin, and other expectorants, for bronchial congestion.

317. The influence of stimulants on congestion may be illustrated by the microscope. A solution of capsicum applied to a frog's web, congested after previous irritation, causes an enlargement of the arteries, and an increased flow of blood to and through the congested vessels. This flow restores motion where it was deficient, sweeps away the accumulated blood, and, in some instances, causes the vessels to contract afterwards to their natural size; so that the congestion is completely removed. In some cases, however, the stimulus fails to clear the congested vessels; the enlarged arteries pour in more blood; but this not overcoming the obstruction, increases the congestion, and, as we shall afterwards see, may convert it into inflammation. Thus both stimulants and astringents, although occasionally remedies for congestion, sometimes tend to increase it; and this they are most likely to do when the congestion is great or of long continuance, or when its causes are still in operation.

318. Under such circumstances, congestion is better relieved by another class of remedies, depletion, and various evacuants. Blood-letting, by puncture or incision in the congested parts, enables the distended vessels to unload themselves, and they may recover their size; and the utility of this expedient is shown in scarifications of congested conjunctivæ and tonsils. But the blood is more usually drawn from the vicinity of the congested part, as by cupping, or leeches on the chest or side for congested lungs or liver;* to the sacrum for congested uterus; or by leeches to the anus for congested intestines. Or, without actually shedding the blood, it may be drawn away from the congested part by derivation; that is, by agents which cause determination of blood or congestion in other parts; as dry cupping, mustard poultices, and other stimulating applications to the surface, and by purgatives and other evacuants from the interior.

* It is remarkable how quickly congestions may be reduced by these means. I have known a congested liver, which reached from the umbilicus to the fourth right rib, (as traced by percussion,) reduced in twelve hours to its normal dimensions by cupping and free purging. Piorry describes a still more speedy reduction of the liver in ague, by the influence of the sulphate of quinine

319. The operation of several of the foregoing agents, in combination or succession, is generally more effectual than that of single ones in the cure of congestions. Thus congestion of the liver may resist the action of mercury, and may even be aggravated by it, (§ 294,) until the vascular distension has been partially reduced by local blood-letting or derivants; then the mercury, by increasing the secretion, reduces the remaining congestion. Congestion of the kidneys is augmented rather than diminished by diuretics, which then fail to increase the secretion of urine, but may only render it more albuminous, (§ 304.) But after some relief has been given by cupping to the loins, and hydragogue purgatives and diaphoretics, then some diuretics, particularly digitalis and cantharides, cause a freer flow of urine with less albumen. The same point might be further exemplified; but it is unnecessary to multiply instances.

320. The cause of congestion being, in many instances, atony of the vessels, (§ 290,) it may often be counteracted by circumstances which augment the tone of the vessels, locally or generally. Thus cold, astringent, or, occasionally, stimulant applications, by bracing the fibres and invigorating the circulation in a part, (§ 124,) render it less liable to congestion from disease; and general tonic measures operate in a similar way on the whole system. Probably the efficacy of bark and arsenic in preventing, as well as in removing internal congestions in ague, depends on their power of augmenting the tone of the vessels of these parts, (§ 315.) A similar virtue seems to be possessed, in some degree, by iodine and its preparations, especially the iodide of potassium; under the use of which the disposition to local congestions is diminished, and those formed are sometimes dispersed. Mineral acids and other tonics have a like effect in cases of general weakness. The treatment calculated to remove the results of congestion will be considered under the subjects, Flux, Dropsy, and Inflammation.

SECTION V.

LOCAL HYPERÆMIA—EXCESS OF BLOOD IN A PART.

II. WITH MOTION INCREASED—DETERMINATION OF BLOOD.

321. Numerous examples of this kind of active hyperæmia are presented in health as well as in disease. Blushing, the growth

of the stag's antlers, and the uterus and breasts at the periods of gestation and lactation, furnish instances occurring in health. The increased number and size of the blood-vessels, manifest by the vascular redness in these cases, show the increased quantity of blood in the part; and the stronger pulsation of the arteries leading to the part indicates the augmented motion of that blood, (§ 274.)

322. In disease we meet with many examples. Determination to the head is one familiarly known; and it affords the opportunity of displaying one of the characteristics of determination, in the enlargement and throbbing of the carotid arteries. I have witnessed this phenomenon in a great variety of cases. One patient was subject to attacks of determination of blood, which caused him so much suffering and loss of moral control, that he cut his throat to destroy his life. When recovering from the wound, attacks sometimes came on; first with beating of the carotids, then flushing of the face and head, suffusion of the eyes, and sensations of distraction in the head. In the slighter attacks, these symptoms would all pass away in a minute or two. I have, in several cases, observed the same symptoms usher in the paroxysms of mania.

323. Fits of epilepsy and convulsive hysteria are immediately preceded by throbbing of the carotids, which shows that determination of blood is the proximate cause of the paroxysm. Drs. Darwin and Parry relate cases in which convulsive fits were prevented by pressure on one of the carotids; and I have practised this expedient with success in several instances. Many of the epileptic patients whom I have questioned have stated that the fit is always preceded by palpitation, which, for reasons before explained, (§ 266,) sometimes peculiarly determines blood to the head. But without the patient being conscious of palpitation, there may be determination of blood to the head; and in numerous observations, I have found this to be so commonly present, that I believe it to be the common immediate cause of the sudden paroxysms of various kinds of disorder which affect the nervous centres. Infantile and puerperal convulsions are probably to be included in this remark, although they may be connected with very different conditions of the vascular system in point of fulness.

324. But the most common cases of determination of blood are those caused by the application of stimuli. Thus heat causes a flow of blood to the surface; snuff, to the nose and eyes; spices in the mouth, to the salivary glands; food in the stomach, to its secernent vessels; purgatives, to the vessels of the intestines, and those of glands connected with them; diuretics, to those of the kidneys, &c. &c. In fact, in the operation of most medicines,

there is an increased flow of blood to particular organs or surfaces; and there are few diseases unconnected with local determination of blood. We shall find hereafter that it occurs in inflammation as a part of that complex process; but Dr. Parry was wrong in supposing that inflammation consisted in this alone.

325. Now, what is the physical cause of determination of blood? In some cases, increased action of the heart (§ 112) may propel the blood with unusual force and quantity to the arteries in its immediate vicinity, (§ 266;) and thus determination of blood to the lungs, the neck, and head, is a common result of inordinate action of the heart. But in many of the examples above cited, (§ 323, 324,) local determination takes place without any increase of the heart's action.

Is determination of blood caused by *increased* action of the arteries? The only active property which we know these vessels to possess is that of slow or tonic *contraction*, (§ 120;) and such contraction of arteries leading to a part would diminish instead of increasing the motion and quantity of blood proceeding to the part, (§ 294.)

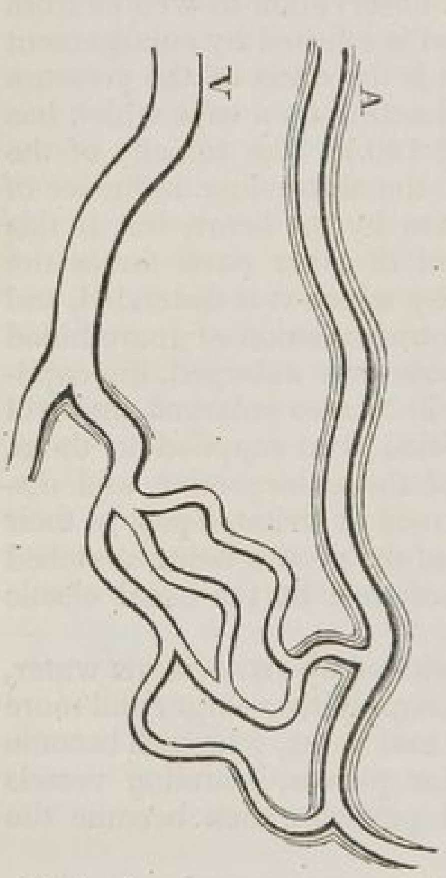
326. We may answer, from direct observation as well as from reasoning, that determination of blood is effected by enlargement of the arteries; and this enlargement is the effect of the pressure of the arterial distension from behind acting on a tube which has lost some of its contractile power, (§ 120.) The tonicity of the arteries makes them naturally resist the distending influence of the mass of blood pumped into them by the heart; but if this tonicity be impaired in any part, that of other parts forces the blood in augmented quantity into it, by which it is distended, and becomes an enlarged channel for the transmission of more blood and more force, (§ 323.) If the arteries are enlarged, the capillaries and veins leading from them will be also enlarged, and will share the increase of blood and motion thus supplied to them, (§ 298, *note.*) We find the proof of the enlargement and distension of arteries leading to an inflamed or irritated part in their increased and harder pulse; the coats of the vessels being stretched to tightness, the pulse is no longer softened by the usual elastic spring.

So, too, in the frog's web gently irritated by an aromatic water, we see the arteries become enlarged, supplying a larger and more rapid flow of blood to the capillaries and veins, which all become enlarged also; and the whole vascular plexus, including vessels which before scarcely admitted red particles, then become the channels of a much increased current. This is determination of blood.*

327. There appears, then, to be no difficulty in tracing local determination of blood to its physical cause, enlargement of the arteries leading to the affected part. But it is not equally easy to find a physiological explanation of the cause of this enlargement. The terms "active dilatation" (Hunter) and "vital turgescence" (Kaltenbrunner) have been applied to the condition in question; but all that is known of animal physics is opposed to the possibility of there being a power of active dilatation in the arteries.

The physiological condition seems to be a weakening or reduction of the tone (§ 123) of the artery; so that it becomes passively distended by the vis à tergo. In some cases, it might be supposed that this weakness is the result of previous stimulation, (§ 116;) and it has been stated above that a momentary contraction of the artery precedes its dilatation. But the dilatation is out of all proportion to the previous contraction; and, in some cases, as in

Fig. 1.



* As these phenomena have not been distinctly described by observers apart from the further effects resulting from over-irritation, which leads to obstruction and inflammation, I will state shortly some results of many observations on the circulation of the frog's web, under the influence of moderate stimuli applied to it. These observations were made in the summer of 1841, and some of them are mentioned in my Gulstonian Lectures, published in the Medical Gazette of July 1841.

The arteries may be distinguished from the veins in the frog's web, not only by the direction of their current and its greater rapidity and transparency, but also by a series of lines along their course, marking the size to which they have been distended at some previous time. (See A, Fig. 1.) These lines or channelings are most distinct, and are more remote from the artery at its angles or bifurcations. They are to be seen sometimes along the veins, but much less distinctly. Now these lines are in themselves proofs of the varying distension of the arteries, and they also furnish the means of measuring this varying distension.

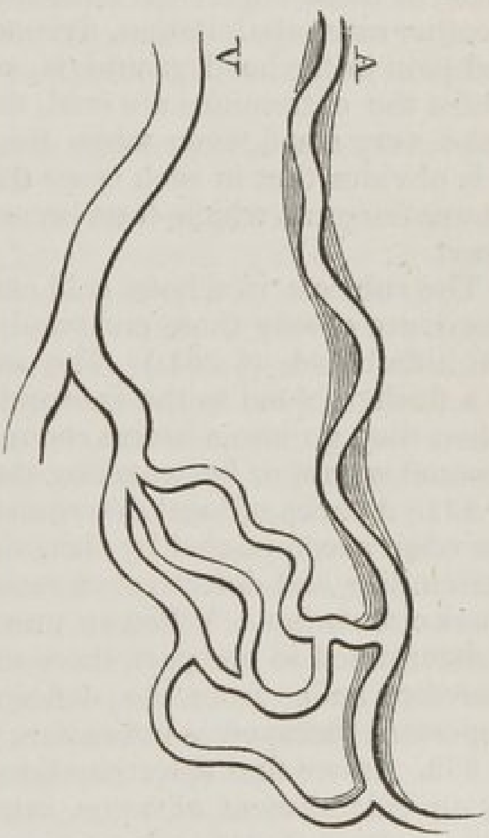
When a weak infusion of capsicum is applied by a camel's hair pencil to the web, there is a momentary retardation of the current in the veins, and the artery distinctly shrinks in size. But in a few seconds the reverse takes place; the blushing and the growth of parts, there is no sign of any previous contraction.

Dr. Billing ingeniously conceives that, by stimulating the nerves, the nervous influence is drawn away from the vessels; and that their contractility, being derived from this influence, is thus impaired. But besides other objectionable points, this view assumes that muscular irritability, even its lowest form, tonicity, is a property derived from the nerves—an assumption unwarranted by the facts and opinions most generally received by physiologists, (§ 110.)

328. There can be little doubt that the nerves—especially the sympathetic (§ 152)—are sometimes concerned in causing determinations of blood; and it is not improbable that their influence is that of reducing the contractility of particular arteries, just as strong moral emotions, acting through the nerves, paralyze the sphincters and muscles of voluntary motion, (§ 144, 154.) But

artery swells to beyond its former size, and reaches the utmost line of its channel; the flow of blood through it is too rapid to be distinguished, and all the capillaries present a scene of busy motion; in some the particles passing in numbers and speed greater than the eye can appreciate; in others, before invisible, single files force their way in more deliberate, but continuous motion; whilst in the veins the movement is again more rapid. This motion begins to flag, and becomes remittent or oscillatory in some capillaries; and it is seen that the arteries have already begun to shrink in size, and the channelled lines which they had reached reappear. Sometimes, in shrinking, the artery assumes for a time a more tortuous shape than before, (as in Fig. 2;) so that its walls cease to be parallel with the lines, which seem to show that it contracts in diameter before its length is proportionally reduced. The contraction of the artery, and consequent reduction of the quantity and movement of the blood in the vascular plexus, was promoted by repeated applications of cold water, (§ 124,) which in some instances stopped the motion of the blood, altogether, by contracting the artery to so small a size, that no blood particles entered it. A solution of acetate of lead also produced this effect.

Fig. 2.



The determination of blood thus excited produces an increased redness quite visible to the naked eye; but it is less intense, and more florid than the redness of inflammation or congestion.

the laws of tonticity, and its relation to the nervous influence, require further investigation.

329. We can see something of the *final* cause of determination of blood. "Ubi stimulus, ibi fluxus." The flow is intended to support the well-being and function of the part. If any influence disturb its well being, or excite its function, more blood is wanted: the arteries dilate to supply more and in greater force, and thus the circulation through the part is augmented. The result is, in moderation, to increase the redness, warmth, sensibility, secretion, nutrition, and other functions of the part; in excess, to disorder and alter them.

330. We have hitherto considered local determination of blood as resulting from causes which directly affect that part of the vascular system in which the determination takes place. In not a few cases, however, the same result arises from opposite causes, acting on other parts of the vascular system. Thus as we found external cold cause external congestions by intropulsion, (§ 292,) so too it may occasion internal determinations of blood. By constricting the vessels of the surface and extremities, it directs the force as well as the quantity of the circulating fluid on internal parts, or those beyond its influence. Thus, in many persons cold weather causes palpitation, dyspnœa, pain in the chest, throbbing and pain in the head, gastralgia, colic, and fluxes of various kinds, whilst the extremities are cold, the surface chilly, and the radial pulse very small, even when the heart beats with great force. It is obvious that in such cases this force is expended chiefly on internal organs, which thus become the seat of determination of blood.

The subjects in whom cold causes internal determinations of blood, are chiefly those endowed with much irritability, (§ 113,) but little blood, (§ 261.) The same persons likewise are liable to a flush of blood to the face and head, with coldness of the feet, when they go into a warm room. By cooling the head, the feet become warm; or by warming the feet, the head cools.

331. Attacks of local determination of blood from other causes are often accompanied by shivering fits, pallidity, coldness of the extremities and defective secretions, particularly in persons of weak circulation. When an unusual quantity and force of blood is determined to one part, there must be less in other parts, which therefore suffer from the deficient supply. This furnishes an important therapeutic indication, to be noticed hereafter.

332. As we find determination of blood to be chiefly produced by an enlargement of some arteries from a reduction of their tonic power, (§ 326,) so we may be led to expect that such enlargement may affect any part of the arterial system. We have chiefly considered it in relation to the distribution of blood to

parts; but it may also occur in the great arterial trunks. Inordinate pulsation of the aorta, especially in the abdomen at the cœliac axis, or at the bifurcation into the iliacs, (corresponding with a little below the epigastrium and umbilicus,) is a common symptom in nervous subjects. Epigastric pulsation I have found frequently before and after hæmatemesis. In one case, hæmaturia and lithic deposits in the urine occurred in a woman affected with strong pulsation at the umbilicus.

SYMPTOMS AND EFFECTS OF DETERMINATION OF BLOOD.

333. Many of the symptoms of determination of blood may be learned from the preceding illustrations. It generally exalts contractility, (§ 112,) sensibility, (§ 126,) and other nervous properties (§ 149) of the part, causing spasm, pain, irritation, and sympathetic disorder. In its moderate degrees, it increases the natural secretions of the part, (§ 162,) and thus becomes the cause of mucous, bilious, and urinary fluxes, &c. The nutritive function is likewise increased, and more naturally than from congestion, the result being a more simple and general hypertrophy of the part. The process of absorption, although favoured when the current is accelerated without distension, is often not equal to the effusion. Hence in sacs and cells determination of blood may cause dropsy.

A few examples will suffice to illustrate the symptoms and effects of determination of blood.

334. The parts most subject to determination of blood are those most freely supplied with blood-vessels, (§ 30,) as the brain, the parenchyma of glands, mucous membranes, and the skin.

335. Determination of blood *to the head* often takes place in some persons from mental excitement, violent exertion, stimulant drinks, or defective excretion. The symptoms vary considerably; but increased beating of the carotid and temporal arteries, some flushing of the face and suffusion of the eyes, and an increase of the symptoms on stooping, or lying with the head low, are commonly perceptible in all cases. The other symptoms are sometimes those of simple excitement of the nervous centres, painful throbbing in the head, excessive sensibility to light and sound, flashes in the eyes, noises in the ears, an excited state of the mind, rapid flow of ideas, sometimes bordering on delirium, wakefulness or dreamy sleep, restlessness and irritability of temper. Sometimes these symptoms are replaced by others indicating a temporary oppression of nervous functions, such as giddiness, drowsiness, stupor, imperfect vision and hearing, with apparent specks or mist in the eyes, impaired articulation, and power of locomotion, occasionally with various convulsive affections, as in hysteria and epilepsy.

336. It may seem difficult to explain how such opposite symptoms, those of excitement and those of oppression, are produced by the same cause—determination of blood. But the explanation is readily found on referring to the true nature of determination, and the different modes in which it affects the circulation within the head. Moderate excitement of the brain, as by bodily exercise, mental exertion, or certain beverages, such as tea and coffee, is accompanied by increased but equal flow of blood through the brain. But if these or other causes of excitement operate in excess, the arteries supplying the brain are still further dilated, and convey blood to it with more force without an equal increase in the passage of the blood *through* it; and this for two reasons. 1. We have already found that a certain proportion in the size and elasticity of the vessels best qualifies them to transmit blood freely, (§ 301;) and that where this is wanting, increased force does not compensate for it, but often causes new disorder. Thus in violent palpitation of the heart, the aorta, carotid, and subclavian arteries are often dilated, and throb strongly; but the weak pulse at the wrist shows that much force is expended on the larger trunks, without reaching their distant branches. This too is one reason why, in determination of blood to the head, the force is sometimes more expended in the larger vessels at the base of the brain than transmitted throughout its substance. 2. Another reason for unequal or defective excitement from determination of blood to the head, is the unyielding nature of the skull, which permits no considerable enlargement of any of the vessels within it, without a corresponding diminution of other vessels, and a general compression of the cerebral substance. Hence distension of the arteries beyond a certain degree, will compress and obstruct the small veins, and thus prevent that freedom of circulation on which functional activity depends. On these principles may be explained the production of symptoms of depressed as well as excited energy of the nervous centres, and often a mixture of both, from the same cause, determination of blood, (§ 153.)

337. Determination of blood *to the kidneys* is caused by stimulating diuretic drinks, and besides the increased flow of urine, may produce pain in the loins and throbbing in the abdominal aorta. Excitement of the circulation, by exercise or by nervous affections, also reaches the kidneys; exercise carries off much fluid by the skin; but nervous excitement, where it fails to cause perspiration, determines more to the kidneys, and this seems to be the source of the abundant flow of limpid urine which follows convulsive and other nervous affections.

338. Determination of blood *to mucous membranes* is exemplified in certain forms of dyspepsia, in which sudden pain, or

heat, or nausea, is felt in the stomach, accompanied by epigastric pulsation, and sometimes followed by eructation of sour or other liquid, and sometimes by hæmatemesis. These attacks are often induced by excitement, general, or local, from irritant ingesta.

339. Determination of blood *to the skin* is often produced, not only by direct irritation, but from the influence of internal causes; as in case of blushing from mental emotion, flushing of the face, from acid in the stomach, and the general redness of the surface in reaction after cold, or at the commencement of fevers. In various chronic skin-diseases the effect of determination is seen in a brightening of the colour of the eruption, which may take place in a few minutes.

340. Determinations of blood are often transient, coming on suddenly and soon subsiding. When they are more permanent, they commonly lead to other disorders. In their immediate seat they cause either increased secretion, with the addition of more or less of the watery, saline, and albuminous parts of the blood, or hæmorrhage, or they may pass into inflammation. In other parts of the body, there is often, at first, coldness, and defective circulation and function, (§ 330,) but afterwards there often succeeds a febrile reaction, with hot skin, accelerated pulse, scanty secretions, and other symptoms of inflammatory fever.

341. The frequent recurrence of determination of blood, or its long continuance in a lower degree, affects the structure; increased nutrition, hypertrophy, being the result. This may be a natural kind of hypertrophy, as in the case of muscles, which increase in size in proportion to their exercise, which increases the circulation of blood through them. So the uniform hypertrophy of the substance of the heart, and of other organs, after long continued excitement of that organ, may be referred to the increased determination of blood that has been kept up. In other cases parenchymata, as those of the kidneys and liver, exhibit alterations rather than mere growth; and albuminous deposits and granular degeneration result. In these and other cases the effect on the structure is commonly modified by the occasional presence of congestion, inflammation, and the plastic condition of the blood itself, (§ 211.)

It is unnecessary to dwell further on the phenomena and results of determination of blood, as we shall have to advert to them in connection with its occasional results—flux and hæmorrhage, and with inflammation, of which it is a component part.

REMEDIES FOR DETERMINATION OF BLOOD.

342. In the treatment of all cases of determination of blood, as of diseases in general, it is obviously proper, as much as possible,

to remove the exciting causes. Thus in the numerous class of cases arising from the action of stimuli or irritants on the part which is the seat of the determination, (§ 324,) the removal of such irritants, or the diminution of their action by soothing or diluent remedies, is a first indication.

343. If we are correct in tracing local determinations of blood chiefly to an atonic distension of the arteries supplying the part, (§ 326,) we may expect measures which promote their contraction to be efficient remedies. This is the fact; for cold is one of the most effectual means which we possess, in subduing determinations of blood; and this was mentioned as a chief remedy for the element, defective tone, (§ 124.) Astringent applications are equally useful in some instances of local determination; as in the application of solutions of acetate of lead, sulphates of zinc and copper, nitrate of silver, and other astringent lotions to external surfaces, (§ 326, *note;*) but these are chiefly useful where the determination is quite local and unconnected with generally increased circulation, otherwise they become irritants rather than astringents, (§ 317.) But besides cold and other astringents to the part which is the seat of the determination, and to the arteries leading to it, *derivants*, or means which draw away blood by relaxing other parts of the vascular system, are especially indicated by many preceding observations, (§ 330, 331, 340.) Of these derivants, heat is the most effectual, especially when combined with moisture.

344. Thus cold lotions or douche to the head, and the hot footbath, are among the best remedies for determination to the head. Taking copious draughts of cold water, or more sparingly of iced water, will often relieve epigastric pulsation and palpitation of the heart. The warm bath, by deriving to the surface, will diminish the flow of blood to the kidneys. I have known severe nephralgia instantly relieved by cold affusion on the loins; but the practice is too hazardous to be recommended.

345. Various evacuant remedies may also be employed to counteract determination of blood, by determining a flow in another direction; and thus purgatives, diuretics, and diaphoretics, are often useful. Of these, purgatives are by far the most powerful and sure in their operation, and of great efficacy in determinations to the head. Change of posture, by elevating the part which is the seat of determination, may sometimes be usefully practised.

346. But the most powerful derivant is blood-letting, general or local. By the microscope it may be seen how opening a blood-vessel changes the currents of blood; the currents of many vessels are reversed and drawn towards the bleeding point, whilst in others they are retarded where they were before running with

great speed. But blood-letting is unnecessary and injurious in many cases of determination of blood, especially those attended with a deficiency of blood in the whole system; and, as we have seen, such cases are not rare, (§ 330.) Dry cupping is a good substitute in some instances; but even this measure is more weakening than it is generally supposed to be, for much blood being extravasated into the skin and cellular texture, is really lost to the system, as blood—its particles are changed, and their structure destroyed.

The cases in which blood-letting should be used are those where determination to an important organ is combined with some general plethora or local congestion, or has continued so long as to threaten a termination in inflammation. A speedy blood-drawing, as by cupping or free venesection, will generally answer best.

347. In the same class of cases, certain remedies are useful which seem to cause a general relaxation of the tonic fibres (§ 122) of the vascular system, and an equalization of the force and blood which this system conveys, (§ 331.) Antimony is the chief of these; and it is most indicated where febrile reaction has begun.

348. Another class of remedies suitable for determination of blood, attended with much excitement, are sedatives, or those which reduce the heart's action, (§ 115,) such as digitalis, hydrocyanic acid, and nitre. These are chiefly useful where the determination occurs in connection with palpitation, as in the case of the various convulsive or other sudden nervous attacks which I have proved to be so commonly excited by palpitation, (§ 322–3.) I have entirely cured several cases of convulsive hysteria, and much reduced the frequency of the fits in epilepsy, by these remedies, sometimes combined with cold affusion on the head in the morning, and the hot footbath at night, (§ 331.) Hydrocyanic acid probably operates chiefly on the organic excitomotory nerves, and by lowering their function prevents the undue excitement which they communicate to the heart. In this respect it surpasses conium and hyoscyamus, which are also sometimes useful in preventing determination of blood arising from nervous excitement.

349. We have found (§ 330) that in many instances determination of blood to internal organs results from weakness of the circulation, and especially a want of tone in the whole vascular system, (§ 123;) so that under the operation of cold constricting the external vessels, or irritations exciting internal organs, the latter monopolize most of the blood and force of the heart's action. In such cases, besides temporary means to equalize the circulation, (heat to the extremities and surface, cold and astrin-

gents to internal organs, gentle exercise, friction, &c.,) more permanent remedies are to be sought in tonics, and various particulars in diet and regimen, which give strength to the contractile fibre, (§ 124,) and improve the quantity and quality of the blood, (§ 271.)

Thus preparations of iron and bark are useful remedies in cases of the weaker kind; mineral acids, iodide of potassium, mild bitters, and the slighter metallic tonics, nitrate of silver, sulphates of zinc and copper, are serviceable in others which will not bear the stronger tonics. In the use of any of these remedies it is necessary to guard against their exciting effects on the parts which are the seats of determination, by premising or conjoining the temporary remedies (§ 342, &c.) against that condition, and by keeping the secretions free and equally balanced.

In all cases, country air, and exercise suited to the strength of the patient, and habits of posture opposed to the peculiar determination, will be found useful in removing and preventing this morbid affection.

SECTION VI.

RESULTS OF HYPERÆMIA.

350. Before we proceed to the third and more complex variety of local hyperæmia, inflammation, we must notice some remarkable results to which the other varieties, when increased to a certain degree, tend, when yet short of the conditions necessary to constitute inflammation—I mean, hæmorrhage, flux, and dropsy. These results have been already mentioned as sometimes ensuing from plethora, congestion, and determination of blood, and in describing hæmorrhage, dropsy, and flux, it will be unnecessary to do more than exemplify their occurrence in connection with these proximate elements, and to trace the further peculiarities which distinguish each of these results.

I. HÆMORRHAGE.

351. When in any form of hyperæmia the blood-vessels are distended to a great degree, they sometimes give way and blood is effused. I shall give illustrations of the more common cases of hæmorrhage proceeding from the kinds of hyperæmia which have been already described.

General plethora (§ 275) not unfrequently causes hæmorrhage from the nose, (*epistaxis*,) from the stomach, (*hæmatemesis*, vomiting of blood,) from the rectum, (*hæmorrhois*,) and into or upon the brain, apoplexy.

352. Congestion from *venous obstruction* (§ 289) produces hæmorrhage in the cases of *pulmonary apoplexy*, (hæmorrhage into the parenchyma of the lungs,) from obstructive disease of the left side of the heart; bronchial hæmorrhage and *hæmoptysis* (spitting of blood) from tubercles in the lungs; hæmatemesis and bleeding piles from obstructions of the liver, from disease, or violent straining.

353. Congestion from *weakness of the vessels* (§ 290) often causes hæmorrhage in various dependent parts, in congestive fevers, and in various passive hæmorrhages of weak subjects. A stooping posture has been known to cause cerebral hemorrhage, (apoplexy.) The erect posture may bring on uterine hæmorrhage, (§ 291.)

354. The congestion of the head from the intropulsive operation of cold (§ 292) sometimes leads to epistaxis and apoplexy; that from previous excitement of the stomach and kidneys in drunkards, (§ 294,) occasionally causes hæmatemesis and *hæmaturia*, (bloody urine.) The congestion of the kidney in scarlatina is sometimes followed by hæmaturia.

355. Hæmorrhage, from determination of blood, (§ 322,) is exemplified in cases of epistaxis and apoplexy, preceded by increased beating of the carotids, flushing of the face, &c., (§ 335;) hæmatemesis from various irritants in the stomach, (§ 338;) hæmaturia from stimulant diuretics, (§ 337;) bloody dysentery from drastic purgatives, &c., (§ 324.) So also we shall find hæmorrhage to be a common concomitant or result of inflammation.

356. But all cases of general or local hyperæmia now noticed do not result in hæmorrhage: some additional element is wanting; and this additional element may be either in the *blood-vessels* or in the *blood.*

357. The blood-vessels are sometimes obviously in a diseased state. Inelastic and fragile, from osseous or atheromatous deposit, or aneurismal dilatation, the arteries of the brain become ruptured under the influence of congestion or determination of blood. Softened and lacerable from inflammation or malnutrition, blood-vessels give way in various structures; and in this way hæmorrhage occurs from an inflamed stomach or colon, in tuberculated lungs, and in a diseased uterus. Sometimes actual ulceration opens an artery or vein, and this is not a very uncommon cause of hæmorrhage in chronic ulceration, or malignant disease of the stomach, intestines, and uterus. Mechanical injury may rupture blood-vessels in the kidneys and nostrils: hence the hæmaturia and epistaxis which sometimes follow violent blows in the loins or on the nose.

358. In other instances the hæmorrhagic disposition can be

traced to a peculiar state of the blood, which is defective in fibrin, (§ 196,) but abounding in red particles, (§ 181,) as in petechial fevers, congestive apoplexy, hæmorrhagic small-pox, and other exanthemata. But there are other cases in which the disposition to hæmorrhage prevails without any defect of fibrin or excess of red particles; scurvy and purpura are examples. In the former there is found to be the very reverse of these changes, (§ 185, 196.)* It appears probable that an alteration in the *quality* of the red particles (§ 186) and fibrin (§ 203) is the real evil in these diseases. The readiness with which textures become stained with the colouring matter, the purple, brownish, or particoloured stains left by inflammation, and, in extreme cases, the altered appearance of the blood itself, seem to show the colouring matter to be diseased; and the failure of the healing process, and the remarkably loose and bloodstained appearance of fibrinous coagula which form on the spongy gums, or in wounds, seem to indicate a want of vital plasticity in the fibrin, (§ 211.) Further microscopic observations are wanted on these subjects.

359. Another question connected with hæmorrhages relates to the mode in which the blood is effused. We have just seen that in some cases blood-vessels are distinctly ruptured, (§ 357.) But in other instances blood has been poured out in considerable quantities from various mucous surfaces, and even from the skin, without any discernible breach of vessels, or even of the surface. This statement has been made, particularly in regard to epistaxis, hæmatemesis, and some remarkable cases of hæmorrhage from the skin, occurring successively at different parts of the body. Considering the size of the red particles of the blood, and the absence of any visible pores in the walls of the blood-vessels, even under the highest magnifying powers, it does not appear possible that the particles can escape from the vessels without rupture either of the particles or of the vessels. At the same time, it may be stated that in the frog the red particles do pass through capillaries of caliber smaller than their short diameter; and in so passing I have often seen them rolled up in the manner of an ice-wafer. The appearances of capillary apoplexy, (cerebral hæmorrhage,) and hæmorrhagic inflammations of serous membranes, countenance the opinion that many minute vessels become ruptured at once, probably in connection with an altered condition of the blood; and such minute ruptures occurring in

* In acute hæmorrhagic purpura the fibrin is not deficient, for I have found the blood effused under the skin firmly coagulated. I have before mentioned my experience that purpura is generally connected with imperfect action of the liver, (§ 171.)

membranes would not be discernible by common modes of examination.

VARIETIES OF HÆMORRHAGE.

360. Besides differences in seat, hæmorrhages are distinguished into *active* or *sthenic*, and *passive* or *asthenic;* and the peculiarities of these varieties may be traced to the same elements as the corresponding varieties of general and local hyperæmia, (§ 279,) excess and defect of the contractile power of the heart, (§ 110,) and of the tonicity of the arteries, (§ 120.) Thus hæmorrhages preceded or accompanied by the symptoms of sthenic plethora, (§ 280,) or with determination of blood, (§ 322,) are *active* or *sthenic;* whilst those occurring in connection with asthenic plethora, (§ 281,) or with mere congestion, (§ 287,) are *passive* or *asthenic.* We may therefore refer to the symptoms described under these subjects for the precursory symptoms of each kind of hæmorrhage.

361. But when the hæmorrhage begins, it may modify the previous symptoms in various ways, besides the new local signs which the discharge of blood produces. In active hæmorrhage, the full, hard pulse of sthenic plethora becomes modified by a remarkable jerk or thrill, which is an important symptom where hæmorrhage is only suspected. I have noticed this thrill in the pulse even when the loss of blood has been very trifling, and where no murmur accompanies the heart sounds; and I am therefore inclined to think that it depends on an unusual abruptness of the heart's contraction, (§ 113,) combined with irregularities in the tonicity of arteries in different parts, (§ 326, 332,) which cause these to react in successive jerks at each pulse, instead of simultaneously. In fact, this same thrill sometimes is felt during a paroxysm of determination of blood to a part without any hæmorrhage resulting.

361. If the quantity of blood effused be large, and especially if its loss be rapid, syncope, or various degrees of faintness and weakness, may ensue. The pulse becomes small, weak, and often irregular, the surface and lips pale; either consciousness, or the heart's action, may first fail, according to the posture of the patient, (§ 70,) and the condition of anæmia (§ 262) is induced.

362. Even after this faint state has been induced, in the course of a few hours the increased action (reaction) returns; and it is under the influence of this that the pulse exhibits the greatest degree of the jarring or vibratory character; so that it may feel like a loose wire twanging, or a rough file drawn under the finger. With this state of the pulse, palpitation, throbbing of the great

arteries, and the various symptoms of partial nervous excitement described under the head of anæmia, sometimes occur, (§ 265.) During this reaction the hæmorrhage may be renewed.

363. If the hæmorrhage is inconsiderable, or if it be suddenly checked by styptics before the vascular fulness or determination has been reduced, inflammation may ensue, with increasing strength and hardness of the pulse, heat of skin, and other symptoms of inflammatory fever. On the other hand, hæmorrhage to a considerable extent may remove the hyperæmia, and the various local and general symptoms of oppression, fulness, tightness, pain, and functional derangement which it had produced. Thus we find headache and flushing often relieved by epistaxis; pain and oppression in the chest by hæmoptysis; abdominal pain and pulsation by hæmatemesis, melæna, or hæmorrhoidal flux.

364. But the blood effused may produce various disturbances and symptoms in the parts into which it is effused. Within the head it presses on the brain; and by interrupting the circulation through it, it may cause coma or paralysis, (§ 273;) or it may also break up the substance of the brain, and cause death by syncope (§ 116) and asphyxia combined. In the lungs, the blood may at once suffocate by its quantity, or cause dyspnœa and cough until it is expectorated. Here, too, it sometimes breaks up the texture of the lungs, leading to serious disorganization. In glands it forms swellings, or is mixed with, and modifies, their secretions, as in the case of hæmaturia. In other complete textures, it produces swelling, often followed by local inflammation; as instanced in the cutaneous swellings of purpura hæmorrhagica.

365. Passive or asthenic hæmorrhage may be preceded by symptoms of asthenic plethora (§ 281) or congestion—may be accompanied by symptoms of exhaustion if the loss is profuse, of relief it it be moderate; and anæmia may ensue from excessive loss; or reaction, sthenic hæmorrhage, or inflammation, if the hæmorrhage is too suddenly checked. The hæmorrhage connected with an altered state of the blood is generally of the passive kind, although excitement, or determination of blood, (*molimen hæmorrhagicum,*) sometimes comes on here also.

TREATMENT OF HÆMORRHAGE.

366. As hæmorrhage is commonly a result of plethora, congestion, or determination of blood, the remedies for these morbid elements will be more or less needed in its treatment. But the necessity for using these remedies will much depend on the extent and seat of the hæmorrhage, and the mischief likely to result from its continuance. For example: a moderate epistaxis or

hæmorrhoidal flux needs no treatment: it is a natural cure for a previously existing hyperæmia. But if these hæmorrhages be profuse, whether of the sthenic or asthenic kind, they must be restrained: if sthenic, by artificial bleeding, which is under control, and by derivants to other parts, to reduce the fulness which causes the hæmorrhage: if asthenic, by styptics, combined with derivants, to save the blood, the loss of which is injuring the system.

367. But in some cases, hæmorrhage to any amount may be injurious, and should be opposed from the first, both by remedies for the hyperæmia, which is the cause of the hæmorrhage (§ 345, *et seq.*), and by styptics, which peculiarly counteract this result. Thus hæmorrhage from the lungs, or into the brain or other organ, requires prompt interference. The same rule may be applied to cases of excessive hæmorrhage of any kind in all cases, and of more moderate hæmorrhage in very weak subjects; in all of which the loss of blood is a pressing danger.

368. In *active* hæmorrhage, generally, blood-letting may be used until the hæmorrhage is arrested, or the pulse reduced; and this effect should be sustained by other evacuants, especially purgatives and diuretics. Remedies which diminish the power of the heart, such as digitalis, hydrocyanic acid, and nitre, in those which also reduce the tonicity of the arteries, especially antimonial medicines, are likewise of great use in some active hæmorrhages. Another powerful agent in hæmorrhage, connected with increased action or determination of blood, is cold, (§ 343.) Thus ice, or a stream of cold water on the nose and forehead in case of epistaxis, ice swallowed in hæmatemesis, ice applied externally, or icy water injected, for uterine hæmorrhage, is of considerable efficacy, (§ 344.) I do not approve of the practice recommended by some, of applying ice to the chest, for hæmoptysis; I have seen pneumonia thus induced.

The treatment of *passive* or *asthenic* hæmorrhage, besides styptics to prevent excessive loss of blood, will include remedies for general plethora, (§ 216,) or local congestion, (§ 313, &c.) which may cause the hæmorrhage. Hence general or local depletion, derivants, accompanied or followed by tonics, may be useful.

369. We have now to consider the means calculated to restrain all kinds of hæmorrhage, and which is especially opposed to the causes which more immediately determine this result of disordered circulation, (§ 356.) If blood-vessels are softened, brittle, or actually ruptured or ulcerated, (§ 357,) a chief thing to be done is to diminish the quantity of blood sent to them; and, besides by blood-letting, this may be effected by pressure, posture, cold and astringent applications, and means calculated to tranquillize the whole circulation. Thus epistaxis is sometimes arrested by

pressure on the carotids; uterine hæmorrhage by pressure on the abdominal aorta, or by elevating the pelvis; hæmoptysis by keeping the chest high; and in all cases of hæmorrhage, perfect stillness and a cool regimen should be observed.

370. The other pathological condition which favours hæmorrhage, the altered state of the blood, (§ 358,) is perhaps more directly influenced by the remedies called styptics. Most of these remedies are astringents, causing contraction of the tonic fibres of vessels and other parts, but some of them also coagulate the blood, and in both these ways they may tend to restrain hæmorrhage.

Of those which cause both contraction of the vessels and coagulation of the blood, the most powerful are acetate of lead, alum, sulphate of copper, chloride of zinc, nitric and sulphuric acids. Other styptics, as nitrate of silver, sulphate of zinc, sulphate of iron, and infusion of nutgalls, are certainly astringent, and are generally supposed to coagulate the blood; but Mr. Blake's experiments show that they have not this latter effect when injected into the veins of living animals, (see *note* to § 214.) It is, however, possible that, in a concentrated form, as where applied topically, they may coagulate the blood in the bleeding vessels. This seems to be the effect of nitrate of silver when applied to leech-bites. The actual cautery operates in a similar way.

In some cases of hæmorrhage, the styptic remedies may be applied directly to the bleeding part, as in epistaxis, hæmatemesis, hæmorrhoids, and uterine hæmorrhage. In epistaxis, solutions of alum, acetate of lead, and sulphate of zinc, are sometimes injected into the nostrils, or applied by sponge or lint. In hæmatemesis, sugar of lead, alum, gallic acid, oil of turpentine in small doses, and the mineral acids, given by the mouth, operate directly on the bleeding part. In excessive hæmorrhoidal flux, enemata, containing some of these remedies, are immediately beneficial.

371. In many instances, the bleeding part is beyond the reach of the direct application of styptic remedies; yet some of these administered internally show considerable power in restraining the hæmorrhage. Thus hæmoptysis is assuredly sometimes checked by frequently repeated doses of sugar of lead, (which should be combined with a little opium or conium, to prevent its griping the bowels;) and, according to some practitioners, by ipecacuanha, gallic acid, alum and other astringents. Hæmaturia of the passive kind is diminished by small doses of oil of turpentine; passive uterine hæmorrhage by ergot of rye, and tincture of the sesquichloride of iron. Opium given internally has been found effectual in some cases of uterine hæmorrhage. It is difficult to explain how it operates; but it is probably through that property by which it diminishes many secretions.

372. In some kinds of hæmorrhage, especially those of the intestinal canal, the most effectual remedies are those which increase the proper secretions of this canal and of its allied glands; such as mercurial and saline purgatives, in combination with others of a styptic kind, such as sulphuric and nitric acids, alum, and sulphate of zinc. This mode of treatment is often sufficient in slight hæmorrhages, or dispositions to hæmorrhage from the lungs and uterus, and in purpura hæmorrhagica; and there can be little doubt that it operates on the condition of the blood, as well as by its evacuant and styptic effects.

II. FLUX AND DROPSY.

373. Another result of various kinds of hyperæmia is an effusion of the watery part of the blood with more or less animal and saline matter in solution. This result occurring in secreting organs or open surfaces, constitutes *fluxes;* in closed sacs or cellular texture, it constitutes *dropsies.* There is so much that is common in the pathology of fluxes and dropsies, that we shall avoid repetition by exemplifying them together in the first place; and we can afterwards notice their distinguishing peculiarities.

374. General plethora sometimes ends in flux or dropsy; but such a result most commonly ensues where the blood-vessels are temporarily distended with an undue proportion of watery contents. Thus, if much water be slowly injected into the veins of an animal, the circulation and breathing become embarrassed; and after a time dropsical effusions take place into the abdomen, the chest, and the cellular texture; or a flux (excessive flow) takes place from the kidneys, intestines, or skin; or all these results may occur; and the blood-vessels are relieved of their distension. The same events have sometimes arisen from excessive drinking of any liquid, but chiefly where the kidneys and the skin, the natural emunctories for superfluous fluid in the body, have failed in their office. The drinking largely of a cold liquid when the body is perspiring and fatigued, checks the cutaneous and renal secretion; the blood-vessels become filled to tension, and may relieve themselves in dropsical effusions or diarrhœa. External cold sometimes operates in a similar way; it arrests perspiration, and causes internal congestions, (§ 292;) and if, from previous over-excitement or other defect, the kidneys are unequal to perform what the skin fails to do, general fulness is the result, which tends to issue in some dropsy or flux. The sudden suppression of a cutaneous eruption, or of the discharge from an old ulcer, has sometimes been followed by anasarca, diarrhœa, or bronchial flux, (humid asthma.) The colliquative sweats of advanced phthisis are of the nature of a flux, by which the blood-

vessels, in their obstructed and reduced state, relieve themselves of superfluous liquid. These sweats may generally be stopped by a judicious restriction in liquid food.

375. If we seek instances of local congestion terminating in flux and dropsical effusion, we easily find them in almost every variety of congestion that has been enumerated, (§ 288, *et seq.*) In fact, these are the most common causes of partial dropsies.

The adequacy of venous obstruction to produce dropsy is well illustrated by some experiments of Lower. He tied the jugular veins of a dog, expecting the animal to die of apoplexy; instead of this, the face and head of the animal became much swelled with œdema. He then tied the ascending cava; ascites and anasarca of the lower extremities were the result. Disease affords numerous examples of dropsy and flux from venous obstruction. Aneurism of the arch of the aorta, or other tumours, by pressing on the venæ innominatæ, or descending cava, sometimes cause œdema of the face and upper extremities. In a case (under my care) of malignant tumour involving the roots of the lungs, there were hydrothorax and flux into the bronchial tubes, (bronchorrhœa.) In advanced pregnancy and ovarian dropsy, the legs swell from pressure of the tumour on the iliac veins. Many instances are recorded in which obliteration of a large vein was followed by dropsy of the part from which the vein proceeded. The ascending cava has been found obliterated in persons who had long been affected with ascites and anasarca of the lower extremities. In the University College collection, there is a drawing of such a case, in which a supplementary circulation had been established by an enormous enlargement of the superficial veins of the abdomen. Dr. Watson relates an instance of the same kind.* M. Tonnele has made some observations which favour the opinion that chronic hydrocephalus is caused by a partial obliteration of the venous sinuses of the head, (§ 267.)

But the most common causes of venous obstruction are certain visceral diseases, and these commonly produce either dropsy or flux. Thus the contractile disease of the liver, cirrhosis, is the most frequent cause of simple ascites; and in connection with various functional and structural diseases of the liver, diarrhœa and gastrorrhœa (watery eructations) are apt to occur. Structural disease of the heart, especially if seriously affecting the orifices or valves, commonly causes hydrothorax, bronchial flux, (humid asthma,) and sometimes general dropsy. Pulmonary congestion from causes impeding the respiration, (§ 298,) such as spasmodic asthma, emphysema, laryngitis, hanging, and coma, sometimes results in a bronchorrhœa or hydrothorax. In the

* Library of Medicine, Art. "Dropsy," vol. v.

experiments of Dr. J. Reid, a serous flux into the bronchial tubes ensued after the division of the par vagum, which, by impairing the respiratory action, induces pulmonary congestion.*

376. As we found congestion to arise from weakness of the circulation and atony of the vessels, (§ 290,) so dropsical effusions and fluxes may proceed from the same causes. Thus œdema of the lower extremities is a common sign of extreme weakness; as after severe illness, and towards the fatal termination of many chronic diseases. Colliquative diarrhœa and perspiration (fluxes) sometimes occur under similar circumstances. The œdema and fluxes which arise from weakness will be more readily induced by postures which cause gravitative congestion in the affected parts. Thus continued standing causes swelling of the legs, and leucorrhœa, in persons liable to these results of congestion.

377. Fluxes and dropsical effusions sometimes occur after previous excessive excitement of the vessels of a part. Hence œdema after erysipelas, and the infiltration of serum in cavities and textures after excessive excitement of the vessels of these parts, even when no inflammation has been induced. The gleets or fluxes which follow inflammations of the urethra, bronchi, alimentary canal, and vagina, seem to be connected with the same condition of the vessels that sometimes causes congestion, (§ 294.) Persons who indulge in spirituous liquors often suffer in the morning from waterbrash, for which they find a glass of spirits the best remedy: in this case, however, obstruction in the liver (§ 56, 371) may also co-operate.

378. Fluxes sometimes arise from the intropulsive operation of cold, (§ 77, 292;) thus diarrhœa and catarrhal affections, too transient to be considered inflammatory, are frequently thus induced; and diuresis (flux of urine) is a more healthy example of this effect of cold. It is doubtful whether this operation of cold will suffice to cause dropsy; but it may increase it where it existed previously.

379. The other variety of local hyperæmia, determination of blood, (§ 321,) may produce fluxes and dropsies. The influence of various stimulants on secreting organs and surfaces illustrates the production of fluxes in this way, (§ 324.) Thus snuff in the nose determines a flow of nasal mucus and of tears; spices in the mouth provoke a discharge from the salivary glands; irritating vapours inhaled cause a flux in the air-tubes; purgative medicines induce a flux from the intestines, &c. In these cases, the irritation is short of inflammation, which, although attended with determination of blood and effusion, comprises further effects.

* Edin. Med. and Surg. Jour., vols. 49, 51.

The fluid thus secreted in these several cases of flux from determination of blood, differs from the products of inflammation: it commonly consists of the natural secretion of the part diluted with an unusual proportion of water and saline matter from the blood, and the excess of saline matter sometimes gives the secretion an irritating quality, as in the fluid of coryza, bronchorrhœa, and watery diarrhœa.

Other examples of flux may be referred to determination of blood without special irritations; as the leucorrhœa which precedes and follows the menstrual period, the bronchorrhœa or gastrorrhœa in some cases excited by increased action of the heart, and the sweat succeeding to flushes of blood to the head or other parts.

380. Dropsy is less frequently a result of simple determination of blood; because, independently of inflammation, there are few causes for such determination to closed sacs. But probably the dropsy accompanying tubercles in the peritoneum and membranes of the brain may in some degree be induced by the mechanical irritation of the tubercles causing a flow of blood to the membranes. The sudden mode of attack which tuberculous hydrocephalus sometimes exhibits seems to countenance the same opinion. These cases exhibit the phenomena of determination of blood to the head, described before, (§ 323,) but here this proceeds to effusion of serum, with its more permanent symptoms. The kinds of dropsy called inflammatory may be included under this head; but we shall shortly see that the determination of blood, or excitement of the circulation, sometimes present in such cases, is consequent on an altered condition of the blood itself.

381. As flux and dropsy commonly arise from similar conditions of the vascular system, so they are sometimes found to succeed to one another. Thus Andral mentions a case in which hydrothorax was removed on the occurrence of a profuse flux from the air passages. Examples are not uncommon of the subsidence of ascites on the occurrence of diarrhœa, or of the supervention of ascites when a diarrhœa of long duration has been suddenly checked. Dr. Watson quotes from Dr. Farre's lecture an instance in which hydrocele was removed by violent purging. It is a more familiar fact that the occurrence of dropsy is attended by a marked diminution of the urinary secretion, and that a free flow of this often reduces the dropsy. On a knowledge of the preceding facts may be founded the most effectual treatment of dropsy.

382. Enough has been said to show that flux and dropsy, as well as hæmorrhage, are occasional results of hyperæmia in its different varieties. But what are the circumstances which deter-

mine these results? In the case of hæmorrhage, we found the additional or determining cause to be in the vessels or in the blood, (§ 350.) So certain conditions of these favour the occurrence of flux and dropsy. An extreme amount of vascular distension will pretty certainly result either in rupture and hæmorrhage, or in the exudation of the watery parts of the blood, (§ 305, 340,) and the long continuance of congestion or plethora, by making the exhalation predominate over absorption, rarely fails to lead to similar consequences. But in some cases both dropsical effusions and fluxes take place with a facility disproportioned to the amount of hyperæmia or to its duration; and in these cases the cause may be traced to a generally lax, flabby state of the tonic and contractile fibre, (§ 123,) or to a poor watery state of the blood, (§ 222,) or to both these conditions together. Persons liable to these affections are usually of pale complexion and phlegmatic temperament, (§ 40.)

The influence which relaxation of the solids has in producing profluvial and hydropic affections is exhibited in the occurrence of these results, in parts after over-excitement, (§ 294,) where there is no indication of general disease of the blood. But in cases also in which the blood is diseased, there is usually a relaxed state of the vascular fibre; and it is not easy to distinguish the separate influence of these causes. Thus the liability to dropsy and fluxes, after long fevers, defective nourishment, (§ 63, 196,) or confinement in impure air, must be attributed to the joint operation of both classes of causes.

383. The conditions of the blood tending to watery effusions require further consideration. A poor or watery state of the blood, above noticed, is the most obvious of these; and that this is alone sufficient is plain, from the fact that injecting water in quantities into the veins of an animal, will cause watery effusions or discharges, whilst the injection of blood or serum does not produce this effect. Persons who have lost much blood are liable to become dropsical from the same cause; the bulk of the lost blood is replaced by watery serum absorbed from various sources; and thus the blood is in a diluted state, (§ 264.) The mode in which a watery blood tends to produce dropsy and flux, is not merely by the greater proneness of thin fluids to transude through the walls of the vessels, but also by the failure and irregular distribution of the force of the circulation. It has been already explained, under the head of anæmia, (§ 262,) that a scantiness of blood embarrasses the circulation. The structure of the heart, its valves and vessels, is adapted to certain degrees of spissitude and quantity of the blood; and when these vary much from the natural standard, when the blood instead of being of an unctuous fluidity, is watery and *squashy*, the hydraulic and moving

apparatus of the heart and vessels is less capable of effecting its propulsion; and this condition of the blood may thus not only facilitate watery effusions, but promote the congestions and other imperfections in the circulation with which flux and dropsy are commonly connected.

384. Several of the circumstances which induce the thin state of the blood have been already stated, (§ 222, 249, 382,) and in its relations to dropsy, we would more particularly advert to imperfect excretion by the kidneys, liver, and skin, as the most common cause. In various forms of hyperæmia, which lead to dropsy and flux, (plethora, congestion, and determination of blood,) it will be generally observed that these results ensue in proportion as the excreting organs fail, and that the removal of these results is to be effected chiefly by means which restore or compensate the defective excretion. In many instances, exposure to cold has been followed by dropsy; and at first sight this might seem to operate merely by checking perspiration, and thus retaining in the vessels water that should be eliminated, and which is then effused within the body. But checked perspiration alone will not cause dropsy: there must be a failure also in the action of the kidneys before this result will ensue. If these act properly, checked perspiration may disorder the circulation, and cause congestions, inflammations, and even fluxes; but I have never met with a case of dropsy arising from exposure to cold, in which the urine was not diseased, and, in the great majority of instances, albuminous.

The circumstances under which exposure to cold induces dropsy, are such also as impair the action of the kidneys. A man in a fit of intoxication lies for several hours of the night on the cold damp grass; he arises much chilled, has shivering succeeded by fever, and general dropsy ensues: the urine is very scanty, and on examination is found to be highly albuminous. The vital properties of the kidneys had been exhausted by the excitement of the stimulant beverage, so that when cold checks the perspiration and throws the blood on internal organs, the kidneys cannot perform their usual vicarious action; their vessels become distended with blood, and mechanically exude serum instead of separating the proper constituents of urine, (§ 309;) these and the superfluous water accumulate in the blood, and, by their quantity and irritating quality cause effusions of serum containing urea in different parts of the body, as well as various other functional disorders before noticed, (§ 170.)

Another instance of a similar kind of general dropsy is that supervening after scarlatina. This has been ascribed by some to a sub-inflammation of the cellular texture, originating in the eruption; by others to the diseased state of the skin, left by the eruption, suppressing the perspiration. But if either of these were the true cause, the dropsy ought to occur most in the cases in which the eruption is most abundant, which is by no means the fact; nay, I have treated several patients in whom anasarca followed a scarlatina fever, with sore throat, without any rash at all. But in all these cases the urine has been albuminous, which again shows that the diseased action of the kidney is the most essential lesion connected with general dropsy. How scarlatina impairs the function of the kidney is a question too extensive to be discussed here; but I will simply state my belief that it does so by causing in these glands a highly congested state, which injures their secreting power, (§ 304,) as a parallel effect is observed with regard to the liver in bilious and intermittent fevers. A female under my care for albuminuria, which was almost cured, became affected with scarlet fever: the urine, which had been merely hazy by heat and nitric acid, now become highly coagulable, and continued so until the fever declined, when it again gradually decreased.

The general dropsical state occurring towards the fatal termination of structural disease of the heart, I have in several cases found to be connected with albuminaria and slight jaundice, and I have been long in the habit of pointing out these as the most surely fatal complications to which heart diseases naturally tend; their connection has been before noticed, (§ 305, 309.)

385. The pathological effect of secretion of serous and scanty urine (oliguria) have been already described, (§ 249, 170,) but we must advert to the mode in which it induces dropsy and flux. Where resulting from a suddenly operating cause, such as exposure to cold, or scarlatina, a febrile state is generally present, with a frequent and hard or sharp pulse, heat of skin, thirst, &c. These symptoms occurring in connection with anasarca have led to the use of the terms inflammatory, febrile, acute or active dropsy; and so far as these terms only imply an excited state of the vascular system, they cannot be objected to. But some have employed them to explain the cause of the dropsy, as if this proceeded merely from the excitement or inflammatory condition. That such a condition is present, is obvious not only from the febrile symptoms just mentioned, but also from the buffy state of the blood drawn, and from the dropsical effusions and fluxes being in many cases combined with the symptoms and products of inflammation. Thus the anasarca is often attended with great tenderness, and sometimes with an erysipelatous redness: swellings of the joints frequently have the character of rheumatic inflammation; effusion in the abdomen and pleura is often accompanied by pain or tenderness, and after death slight deposits of lymph are found in addition to the serum; catarrhal flux from

the bronchi, and diarrhœa, are associated with symptoms of more irritation (spasm, constriction, cough, vomiting, pain, and soreness) than occur with simple fluxes.

Now this inflammatory character may be readily explained by referring it to the irritating quality of the excrementitious matter which the failing function of the kidneys leaves in the blood. Under such circumstances, urea has been found in the blood and in various effusions, and may be fairly regarded as the *materies morbi* which irritates various parts, and from which the system, seeking to relieve itself, (§ 17,) excitement and sundry effusions or discharges ensue. In two points this condition resembles acute rheumatism, (§ 351,)—1. in the number of parts which may be simultaneously or successively affected; 2. in the want of any constancy in the seat of the affections. Both these points indicate that the cause is not essentially in any part, but in the blood. Another circumstance which approximates these affections to gout and rheumatism, is the nature of the excrementitious matter which accumulates in the blood. In the latter affections there is good evidence that lithic and lactic acids are the chief ingredients of this matter; but I have so commonly found an excess of urea in the urine of patients recovering from rheumatism, and the chief remedies for gout and rheumatism so distinctly increase the elimination of this principle, (§ 257,) that we can scarcely doubt that in these affections urea also is either produced in excess, or insufficiently excreted. The proximity in composition between lithic acid and urea, and the probable conversion of the former into the latter, (Liebig,) should not be forgotten. Both gout and rheumatism, like oliguria, sometimes produce fluxes or catarrhal affections. Lastly, the connection between these affections is apparent from the fact, that rheumatism is frequently complicated with albuminuria, (as after scarlatina;) and granular degeneration of the kidneys (Bright's disease) is apt to supervene in the most aggravated forms of rheumatism.

386. But besides the retention of excrementitious matter in the blood, there is a loss of albumen from this fluid. That this loss, by thinning the blood, facilitates dropsical and profluvial effusions, is most probable in all instances; but this seems to be the especial cause of these results in the more chronic cases, and in the most anæmic subjects, for in these (as it has been already stated, § 264,) the blood is thinner and more watery than in any other disease. Thus in advanced stages of granular degeneration of the kidneys, and sooner in anæmic subjects, almost every congestion or determination of blood ends in watery effusion. As the powers of the circulation fail, the effusion is connected chiefly with gravitative congestion, (§ 291,) and occurs most in the lower extremities; in this respect differing from the dropsy of acute

albuminuria, in which the swelling also affects the face, trunk, and upper extremities. This form of dropsy is well entitled to the appellation—asthenic or passive, both from being connected with congestion and weakness of the circulation, and from the poor condition of the blood, and depressed or cachectic state of the functions dependent upon it, (§ 262, 185.)

387. From the preceding statements, it may be inferred that acute dropsy arises chiefly from the retention in the blood of excrementitious matter and water, which the kidneys fail to eliminate; and that the more chronic or asthenic kinds, although often originating in the same way, are rather dependent on a poor or watery state of the blood, especially deficient in albumen, (§ 222.) This deficiency in many cases arises both from the continued drain by the loss of serum in the urine, and from the imperfect assimilation and nutrition connected with this state. But we have good evidence that the more chronic and asthenic forms of dropsy may arise from the same state of the blood, independently of disease of the kidneys. Thus Andral and Delafond found dropsy in anæmic sheep in connection with cysticerci of the liver, but only in those cases in which the albumen of the blood was below the natural standard. So too in the human subject; the dropsy induced by very scanty or poor food, or close confinement in unhealthy places, or malarious districts, and that supervening in extreme states of debility or cachexia, are probably dependent, not merely on weak or obstructed circulation, but also on an impoverished condition of the blood itself. For the same reason, the various structural diseases which cause congestions, especially those of the heart and liver, often do not induce dropsy until the quality of the blood is impaired, either by imperfect excretion, or by inadequate nutrition.

388. We have thus traced flux and dropsy in common, to elements previously considered, hyperæmia in some of its forms, together with a diseased condition of the blood itself, (§ 222,) dependent on defective secretion, (§ 249, 250,) or defective nutrition or assimilation, (§ 268.) The latter element, although not essential to the production of fluxes or local dropsies, is the chief cause of general dropsy, and constitutes the dropsical diathesis. If we endeavour further to distinguish between the pathological causes of flux and dropsy, we find from observation that flux more commonly results from determination of blood or congestion, with a lax state of the solids, (§ 123, 382,) whilst dropsy is rather associated with the altered condition of the blood just noticed.

389. The distinction just made between the causes of flux and dropsy implies that flux is generally a more partial disease than dropsy, many circumstances relaxing the vessels of a part with-

out affecting the condition of the blood in the whole system. This is especially apt to occur in secreting organs and surfaces, which are in fact the common seat of fluxes. We have before noticed excessive secretion as a primary element of disease, (§ 162,) but the fluxes which we are now considering consist less in excess of the natural secretion (although this often occurs also) than in the addition of a watery, saline, and sometimes albuminous fluid derived from the blood, a serosity in fact, (§ 305, 375.) The fluids discharged in chronic coryza, bronchorrhœa, gastrorrhœa, and watery diarrhœa, are the natural mucus of the respective surfaces, much diluted with a thin serum, the saline matter of which often gives the secretion an irritating property. Sometimes this serous fluid is substituted for the proper secretion, as in the coagulable urine of the early stages of granular kidney, and the watery urine of its more advanced stages.

The circumstances which commonly induce flux in secreting surfaces have been already noticed, (§ 376, *et seq.*,) but after a flux has continued for some time, it is apt to become habitual, apparently through permanent relaxation of these affected vessels. These become so weak that any circumstance disordering the circulation may bring on an attack of the flux. In fact, the flux becomes an outlet for superfluous fluid in the blood-vessels, and discharges that which ought to be evacuated through the kidneys, skin, or bowels.

GENERAL TREATMENT OF FLUX AND DROPSY.

390. As there is much that is common to fluxes and dropsies, we may abridge our notice of the remedial measures to be opposed to them, by first giving the treatment applicable to both, and afterwards specifying that indicated for each class of results.

In so far as fluxes and dropsies depend on plethora, sthenic or asthenic, congestion in all its varieties, or determination of blood, the remedies for these several morbid elements (§ 283, *et seq.*, 313, *et seq.*, 342, *et seq.*) must form part of the treatment. So, also, according to the prevalence of these constituent conditions, fluxes or dropsies may be more or less sthenic or active, or asthenic or passive, and more or less constitutional or local; and the treatment must be varied correspondingly. And according to whether these conditions are tractable or not, fluxes and dropsies resulting from them may be more or less difficult to remove, and exhibit many varieties as to duration and disposition to return. Thus fluxes and dropsies which arise from congestions caused by structural disease of the heart or liver, or by tumours compressing veins, (§ 375,) although often removed, are liable to return; but those arising from cold, (§ 378,) weakness, (§ 376,) previous excitement, (§ 377,) or functional disorder, may, in many cases, be cured permanently.

391. We have repeatedly stated the circumstances under which vascular congestion or fulness in itself suffices to induce dropsy and flux, (§ 306, 383;) and under these circumstances, the remedies for congestion and plethora are the first to be used. Thus in dropsy or fluxes suddenly induced by structural disease of the heart and liver, often brought on by cold, over-exertion, or excitement, whilst the condition of the blood has not materially suffered, depletion, general or local, is advantageously premised before the use of other measures. Then follow remedies which, by increasing the secretions, reduce the remaining congestion and the effusions resulting from them: combinations of mercury or antimony with squill and digitalis are peculiarly serviceable in accomplishing this object. Various other means contribute to the same end, chiefly those which act as evacuants and derivatives. This treatment approaches to the antiphlogistic, as we have already found the nature and products of congestion of high tension, and of sthenic plethora, approximate those of inflammation, (§ 307.) But in the more peculiar causes of flux and dropsy —those that induce these results with slighter amounts of congestion or disordered circulation, (§ 382)—those which constitute the dropsical and profluvial diathesis, (§ 388,)—we find conditions generally betokening weakness, and requiring a tonic or more supporting plan of treatment; a relaxed state of the solids, and a watery condition of the blood. But even in the treatment of these cases, to derive from the weak or congested parts, and to increase defective excretions, are objects generally to be attempted. Further details will be better described under separate heads of flux and dropsy.

TREATMENT OF FLUXES.

392. In all cases of flux, it is proper to derive from the affected part, and to promote the natural excretions in other directions, by some or other of the following means: warm bathing, warm clothing, exercise, friction, and stimulant applications to the surface, diaphoretic, diuretic, and aperient medicines. It is also necessary to avoid circumstances which promote congestion or determination of blood in the affected part, such as dependent position, exposure to heat, cold to other parts, too fluid a diet, &c. In addition to these measures, it may be requisite to use others to counteract or remove the irritations or obstructions which the flux causes in the part which it affects. Thus demulcent and narcotic remedies are sometimes useful in catarrh and diarrhœa, to

soothe irritation, caused by the secreted fluid; at other times, expectorants and purgatives, to promote its expulsion.

393. The further treatment of fluxes will be guided by the state of the vascular function, whether sthenic or asthenic. As in case of hæmorrhage, so with flux, it is sometimes attended by a hard, frequent pulse, heat of skin, and other signs of fever or of sthenic plethora: here evacuants, antimonials, sedatives, and even blood-letting, may be required. In fact, the disease borders on inflammation, and needs a similar treatment. Some cases of flux, of a sthenic character, arise from gouty or rheumatic matter in the blood: here colchicum and alkalies are the proper remedies, as they promote the removal of this matter by the kidneys. Others we have found to be connected with albuminuria, (§ 380,) and are to be treated as dropsy from that cause. In all these examples of sthenic or active flux, it is neither useful nor safe to attempt hastily to check the discharge by astringent remedies, lest the determination of blood attending it end in a worse result, hæmorrhage or inflammation.

394. The majority of fluxes are, however, asthenic, connected with a weak state of the vessels, local or general; and here other remedies are needful. Together with more or less of the general measures above described, (§ 392,) it is here safe and proper to endeavour to check the profuse exhalation, by astringents, stimulants, and general tonics. Astringent remedies are most effectual by direct application; and their mode of action, by constricting the relaxed vessels, (§ 388,) is obvious. Thus acetate of lead, sulphate and acetate of zinc, sulphate of copper, nitrate of silver, alum, and some vegetable astringents, are effectual in leucorrhœa and diarrhœa. Some of these remedies seem also to act through the medium of the circulation. Thus sugar of lead, sulphate of zinc, and mineral acids, given internally, sometimes distinctly diminish bronchial flux and profuse perspiration, as we have already found they sometimes arrest hæmorrhage, (§ 367.) Some fluxes are remarkably checked by remedies whose operation seems to be rather stimulant than astringent. Thus spices, essential oils, and brandy, sometimes cure pyrosis and diarrhœa; cantharides diminish leucorrhœa; cubebs and copaiba, gonorrhœa; balsams of copaiba and Peru occasionally check bronchorrhœa. It is uncertain how these remedies operate; but it is probably by removing congestions by causing determination of blood, which excites contraction, and a new condition of the capillaries of the part, (§ 317.) They are most successful in asthenic cases originating with inflammation. Another remedy occasionally useful in controlling fluxes is opium: its mode of operation is equally uncertain; but it is probably connected with its power to diminish

natural secretions, (§ 166). Its efficacy is most obvious in diarrhœa and diuresis; and it is sometimes beneficially combined with metallic astringents in bronchial and gastric flux.

The state of the system in persons subject to fluxes is generally one of relaxation, and is therefore benefited by tonic medicines. Some of these have also an astringent property, which peculiarly adapts them for the treatment of asthenic fluxes. Thus the tincture of the sesquichloride of iron is useful in the treatment of leucorrhœa and humoral asthma, attended with much debility; infusion of cusparia in diarrhœa; and bark or quinine, with mineral acids, in various fluxes in very relaxed habits.

For similar reasons, the diet should be as generous as the digestive organs will bear; sometimes including animal food twice a-day, and a moderate allowance of some sound fermented liquor. Excess in liquid food should be particularly avoided, especially tea, and warm *slops* generally. Catarrhal colds, which are acute fluxes, I am in the constant habit of curing simply by total abstinence from liquids during two or three days; and although this extent of *dry regimen* is obviously inapplicable to chronic cases, yet moderation in the use of liquids, especially before or during exposure to cold, is an important part of the treatment in all cases. I have known several instances of chronic coryza and bronchorrhœa kept up, if not brought on, by immoderate indulgence in tea and such liquids. These fluids cause a temporary plethora, which immediately finds vent through the lax vessels of the weak part, (§ 389.) The propriety of warm clothing, regular exercise, and a bracing, but not too cold an atmosphere, is obvious from the previous considerations.

TREATMENT OF DROPSY.

395. In addition to the means requisite to remove the variety of hyperæmia inducing the dropsy, (§ 391,) we have to remedy, as far as we can, those conditions of the blood which we have found (§ 384) specially to favour the occurrence of dropsy. Of the causes of these, a failure in the secreting power of the kidneys is the chief: its sign being an albuminous state of the urine, with a deficiency of the natural constituents of this excretion. The treatment must therefore have regard to the condition of the kidneys, which is the chief cause of this failure in their action, and to the state of the blood and other parts, which is the result of that failure.

We have several times pointed out (§ 309) reasons for supposing a highly congested state of the kidneys to be the first cause of that failure in their function which induces albuminuria and its consequences. The means found most successful in removing dropsy arising from renal disease correspond well with this view. Thus in acute or inflammatory dropsy, occurring after scarlatina or exposure to cold, (§ 384,) blood-letting, especially by cupping to the loins, hydragogue purgatives, and diaphoretics, are advantageously used at first; and subsequently some kinds of diuretic medicines, particularly tincture of cantharides, digitalis, and colchicum, sometimes promote the natural action of the kidneys. Such measures, if employed at an early period, before the disease in the kidneys has affected the structure, are often completely successful. They fulfil, not only the indication of diminishing the renal congestion, but that also of purifying the blood from excrementitious matter, and in reducing the sundry effusions, local irritations, and disturbances, which this matter excites in various parts, (§ 385.) They cure the dropsy by exciting an artificial flux, (§ 381.)

Of the hydragogue purgatives used in the treatment of acute dropsy, I have found cream of tartar in large doses, (ʒiv. to ʒx. every morning or every alternate morning,) and extract of elaterium, (¼ gr.) the most effectual. Tartarized antimony, alone, or combined with opium, is the best diaphoretic, and it often relieves the catarrhal symptoms commonly present. Care must be taken not to cause vomiting, to which there is often a natural tendency. Dr. Osborne recommends the vapour-bath, and Dr. Watson the hot-air bath, as means of deriving to the surface and causing perspiration. After cupping to the loins has been repeated as often as the strength of the patient may indicate, in obstinate cases I have seen some benefit from blisters or other counter-irritants to the loins.

The dropsical effusions are often soon dispersed by the preceding measures; but the proof of the permanent benefit of the treatment is to be looked for in the progressive decrease of albumen, and the increase of urea, and lithic acid in the urine. It often happens that, after the full use of depletion, cathartics, and diaphoretics, the condition of the urine becomes stationary, and does not advance towards a healthy standard. Then the diuretics before named are sometimes very effectual in augmenting the quantity of urine, without increasing the albumen in it; and where this is their first effect, their continuance will often produce a gradual diminution of the albumen. The tincture of cantharides is more powerful than the others in exciting the action of the kidneys; and where it increases the urine, the dose may be augmented from ♏x. to ♏xx. or ʒss. thrice a-day; but if the smaller dose do not act as a diuretic, it is not safe to proceed to the larger, nor in fact, to persist with the medicine; for if it irritates the kidneys without increasing their secretion, it is sure to do harm. We have noticed the same circumstance in the treatment of congestion by stimulants, (§ 317;) if they fail to remove the congestion, they aggravate the mischief. Digitalis and colchicum are safer diuretics, inasmuch as they are less irritating to the kidneys; but they are also less powerful.

Mercury might be expected to be useful in removing congestion or low inflammation in the kidney, and in restoring its secretion; but it so speedily and severely salivates in such cases, without any equivalent benefit, that it is not generally eligible. The promptitude with which the gums are affected with mercury may be ascribed partly to the facility with which inflammations may be excited in any part, (§ 385;) and, in some measure, to the failing action of the emunctories of the system permitting the mercury to accumulate more speedily than usual, (§ 260.) But mercury is peculiarly efficacious in dropsy connected with diseased liver; and, in combination with squill, digitalis, and henbane, or conium, forms the most useful diuretic in all recent cases of dropsy dependent on congestion without disease of the kidneys.

396. We have found (§ 386, 387) that the asthenic forms of dropsy, and those of the most chronic character, are commonly connected with a watery, non-albuminous state of the blood, and general weakness of the system. To obviate this condition so far as possible by nourishing diet, tonics, and means to increase the strength, becomes here a leading indication. In cases depending on malnutrition or mere debility, (§ 387,) this tonic and supporting treatment may be sufficient to effect a cure. In the commoner examples of dropsy, rendered asthenic by the long continuance of structural disease of the kidneys, liver, or other organs, the same strengthening and invigorating measures must be more or less combined with means to excite the failing excernent organs, or to produce some compensating discharge. Thus in dropsy from chronic albuminuria, or advanced degrees of granular degeneration of the kidney, the occasional exhibition of hydragogue purgatives and diaphoretics, and of the diuretics before mentioned, is useful at the same time that bitters with iodide of potassium, or mineral acids, are given to keep up the general strength and powers of nutrition. In the more anæmic cases, iron is often of advantage; but it sometimes proves injurious by impairing the little secreting power remaining in the kidneys, and by rendering the urine more albuminous. Where it has this effect, its use must be abandoned. The preparations of iron that I have found most serviceable in these cases are the ammonio-citrate in combination with iodide of potassium, and the muriated tincture.

Asthenic dropsy arising from diseased liver is sometimes signally relieved by mercurial and diuretic medicines, followed by or even conjoined with calumbo, bark, and other vegetable tonics. In two cases under my care, ascites, of great extent and long duration, connected with granular degeneration (cirrhosis) of the liver, was removed, and the patients for a time restored to apparent health, by a course of hydragogue doses of cream of tartar every morning, or every other morning, with bark and nourishing diet in the day. Hydragogue purgatives are more directly useful in removing ascites connected with diseased liver, inasmuch as they excite a discharge from the congested vessels themselves, and substitute abdominal flux for abdominal dropsy, (§ 381.) But they often fail to excite a watery discharge from the intestines, and instead cause much irritation, with tenesmus, and slimy or bloody stools: under these circumstances they must be discontinued; but after blistering the abdomen, or applying leeches to the region of the liver or to the anus, (§ 319,) the useful operation of hydragogue purgatives may sometimes be again obtained. Similar means will often facilitate the operation of diuretics. Dr. O'Beirne has argued strongly in favour of blood-letting in dropsy, under the impression that by relieving the pressure from congested blood-vessels, it enables secreting organs to act. (Dublin Journ. of Med. Sc., Nov. 1842.) Like most other writers on dropsy, Dr. O'Beirne does not seem to me sufficiently to regard the mixed character of the disease.

397. The tendency of dropsy connected with diseased heart, kidneys, or liver, to recur again and again, and become chronic, renders it needful to vary as much as possible the remedies employed, as well as to use means to support the strength. It is an important point in the treatment of such cases not to exhaust the powers of any secreting organ by too long acting on it, and not to expend the efficacy of any one remedy by too long continuing its use. By employing sometimes diuretics, sometimes purgatives, sometimes diaphoretics, and by aiding each of these, by local depletion or derivants, or by stimulants and tonics, according to the temporary prevalence of vascular fulness and excitement, or the converse, much may often be effected to prolong life. It is in the application of these rules to the treatment of prolonged cases, that the skill and resources of the rational practitioner are most tried, and his superiority over the routinist is best proved. It is under these circumstances, too, advantageous to have at command a great variety of medicines, particularly diuretics, and to alternate them or vary them in order to increase or maintain their effect. Those that I have found most effectual are—combinations of mercury, squill, digitalis, and conium, (not in acute albuminuria;) combinations of decoction of broom, or pyrola umbellata, with nitrate and acetate of potass; the juice or extract of

taraxacum, with the same salts or bitartrate of potass, or with nitric acid, (particularly in hepatic disease;) infusion or tincture of digitalis, with iodide of potassium, and bitartrate of potass, (in dropsy after scarlatina;) the same, together with increasing doses of tincture of cantharides, (in asthenic cases of albuminuria, after cupping to the loins and hydragogue purgatives;) ammonio-tartrate and ammonio-citrate of iron in Seltzer water, (in asthenic dropsy;) gin in cream of tartar beverage, (imperial;) compound spirit of juniper, spirit of nitric æther, with various others, (in cases of debility.) The latter stimulant diuretics have disappointed me more than any of the rest.

398. When dropsical swellings have reached a certain amount of tension, diuretic and other remedies produce little or no effect on them. The veins and lymphatics, whose office it is to remove these swellings, are too much compressed to be capable of absorbing. In the case of ascites, this pressure impedes the circulation through the kidneys and intestines, and their secretions are proportionally reduced, (§ 159.) Extensive hydrothorax, and even ascites, in a similar way embarrass the functions of the lungs and heart. Anasarca, in its extreme degrees, sometimes impedes the circulation in the vessels of the lower extremities, so far, as not only to prevent absorption, but even to cause the death of the parts: hence gangrene of the legs is a common termination of incurable dropsy. The gangrene is commonly preceded by an erysipelatous kind of inflammation, which often seems to originate in some accidental scratch, or from the irritation of mechanical tension, or of the quality of the effused fluid.

Now, in all these cases, the great expedient is to give exit to a portion of the fluid, by tapping or puncturing the parts which contain it. Thus the abdomen is tapped for ascites; the chest for hydrothorax; the scrotum for hydrocele; the brain for hydrocephalus; ovarian and other cysts, when they attain a large size; and the legs are acupunctured for anasarca. The relief afforded by these means is sometimes very remarkable, even when much fluid is left unremoved. In fact, the great utility of these operations seems to consist in the removal of an amount of pressure and distension that was seriously impeding the functions of the several parts. Accordingly we find, after these operations, not only a great mitigation of suffering, but a restoration of the functions of circulation, secretion, respiration, &c., which before were mechanically obstructed. After paracentesis, diuretic and other remedies regain their power, and contribute to reduce the remaining effusion; and the secretions being free, the patient is able to bear nourishing food and strengthening remedies, which previously would have increased the excitement and oppression.

The usual indications for the use of these surgical resources are, an amount of dropsical effusion which seriously injures the functions of circulation, secretion, or respiration, other remedies having failed to give relief. Under such circumstances the operation should not be delayed. In puncturing the legs for anasarca, it is proper to bear in mind the tendency to low inflammation and gangrene, and to avoid this, the skin and flesh should be injured as little as possible; numerous punctures should be made with a fine needle, but not too close together; and inasmuch as there is more tendency to this result where the circulation is weakest and most remote from the heart, it is better to avoid puncturing below the knees.

Further details on these subjects properly belong to special pathology; and would be out of place here.

SECTION VII.

LOCAL HYPERÆMIA. EXCESS OF BLOOD IN A PART.

III. WITH MOTION PARTLY INCREASED, PARTLY DIMINISHED= INFLAMMATION.

399. The morbid conditions connected with the quantity and motion of the blood hitherto described, have been pretty distinctly defined; and we have been able to refer many phenomena of disease to them. We now come to one, the name of which is very familiar, and its frequency gives it so high an importance, that it has always attracted the first attention of pathologists; but although so commonly occurring, it is much more complicated in its nature than any of the morbid elements previously considered; in fact, it may be said almost to comprehend them all, besides being a still further deviation from the natural condition.

The terms *inflammation*, *phlegmasia*, and *phlogosis*, have been used, from a very remote period, to give a figurative expression of the heat, redness and burning and painful sensations which commonly exist in inflamed parts. The occurrence of inflammation is so common, and its more prominent symptoms so familiar, that it has long been distinguished as a chief element of disease; in fact, it has, in a measure, engrossed the attention of pathologists so entirely, that other important elements have been almost overlooked; and this oversight has not only retarded the advancement of our knowledge with regard to these other elements, but it has rendered the subject of inflammation itself less intelligible, by excluding the consideration of some of its component parts, and by keeping it in all its complexity and remoteness from the normal conditions of function and structure. We shall find, that an acquaintance with the ultimate and proximate elements of disease already considered in this work is essential to the proper understanding of the nature of inflammation; for these form the connecting link between the natural properties of living textures, and their extreme variation in the state of inflammation. The definition given above to distinguish inflammation from the other varieties of hyperæmia—*too much blood in a part, with motion* (of that blood) *partly increased, partly diminished*—is easily recognized in the strong pulse of arteries leading to an inflamed part, and in the stagnation of much blood in the part.

400. The four signs which, from the time of Celsus, have been considered characteristic of inflammation, are *redness, heat, pain,* and *swelling.* These signs are sometimes produced by congestion, (§ 303,) and by determination of blood, (§ 333, &c.;) but in a degree less marked, and for a time less continued, than in inflammation; and although there are cases and forms of inflammation in which it is not possible to detect all these marks, they may still be said to constitute its most general character. In common with other varieties of local hyperæmia, inflammation owes the sign of redness to the excess of blood in the part. As in determination of blood, the heat and pain are in part due to the increased motion of that blood. As with other forms of hyperæmia, the swelling arises partly from the over-distension of the blood-vessels, and partly from effusions from them; but in these effusions, inflammation differs from congestion and simple determination, departing still further than these from the natural quantity and quality of the effused matters.

CAUSES OF INFLAMMATION, AND THEIR MODE OF OPERATION.

401. *Predisposition* to inflammation has been already noticed under the head of predisposing causes of disease, (chap. i. sect. 2.) The circumstances which render the body liable to inflammation are those which especially affect the vascular system, whether these circumstances be the result of original conformation, as the sanguine temperament, (§ 38;) or whether they be the effect of previous disease, (§ 31,) of present disease, (§ 34,) or of external or internal causes in actual operation, (§ 20, *et seq.* 30.) Inasmuch as various circumstances, external or internal, tend generally or locally to impair the healthy tone and balance of the vascular system, (§ 123,) whilst muscular irritability (§ 112) and the quantity of the blood are not proportionally reduced, (§ 195,) so far they predispose to inflammation. Accordingly, we find persons prone to inflammation to be those whose circulation has

been weakened or irregularly excited by previous disease, fatigue, confinement, impure air, or improper nourishment. But it will presently appear, that predisposition to inflammation differs according to the nature of the cause which excites inflammation; those most subject to inflammation from causes acting generally suffering more than others from causes which act only locally. Thus a depressed state of the whole vascular system favours the production of inflammation from causes acting generally, (such as cold;) whereas an excited state of the vascular system favours the development of inflammation from local irritation.

402. The concluding part of the last paragraph prepares us to divide the *exciting causes* of inflammation into those which act locally on the part which inflames, and those which act more generally on other parts. The operation of the first class is direct; that of the second is indirect, therefore less certain, and more dependent on predisposition.

The *local* exciting causes of inflammation comprehend *irritants*, *mechanical*, *chemical*, and *vital*. A grain of sand in the eye, a thorn in the true skin, and a bruise or wound in the flesh, are examples of mechanical irritants, or sources of irritation. Chemical irritants are those which operate on living matter by strong chemical affinity, tending to alter or decompose it; such are heat, strong acids and alkalies, various corrosive salts, chlorine, iodine, &c.: these act also on dead textures. Vital irritants are various agents whose irritating operation is not referable to any known chemical property, nor do they act on dead animal textures; of this kind are cantharides, mustard, capsicum, and essential oils. In this last class must be included various animal and vegetable irritant poisons; such as that of small-pox, and the venom of some noxious animals and plants, which act as local irritants, besides otherwise affecting the system. Various noxious matters, sometimes generated in the living or recently dead body, are also capable of exciting inflammation when applied to an abraded surface, (§ 258.) Nay, the natural excretions of the body become most acrid irritants, when brought into contact with serous membranes; thus urine, fæces, and bile, effused in serous membranes, even in the smallest quantities, produce intense irritation and inflammation.

Irritation and inflammation are sometimes caused by excrementitious matter retained in the blood, where the functions of the excernent organs are impaired, (§ 249, 251, 254.) Local inflammations are also excited by certain poisons received into the system: thus arsenic, even when applied to a wound, causes inflammation of the stomach and intestines; mercury excites inflammation of the gums; the poisons of small-pox, scarlatina, and measles, inflame the skin, throat, and air-passages; that of syphilis the periosteum, throat, skin, iris, &c. In these cases, there can be little doubt that inflammation is excited by the actual presence of the peculiar irritating matter in the parts which inflame, conveyed there in the blood; and it is a leading character in the operation of these irritants which are conveyed through the blood, that it affects several parts, or a considerable portion of the body at once; and frequently the two sides of the body in a similar manner. This is observed in the eruptions of exanthematous and other skin diseases, in rheumatism, in syphilitic nodes, &c. (§ 259.)

403. The second class of causes exciting inflammation, those which operate indirectly, are of very common occurrence; and, although comprising fewer agents, they as frequently produce diseases as the more direct causes of irritation. They comprise those which first produce congestion, which, on the occurrence of subsequent reaction, is converted into inflammation. The most common of these causes is cold, which, both by its local operation, (§ 76,) and by its more general application, (§ 77,) may produce congestions, (§ 296, 292,) which may pass into inflammation. Malaria, and the influences which induce continued and eruptive fevers, as they produce congestions, (§ 293,) so they often lay the foundation of inflammations, which complicate the febrile affections excited by these causes. Inflammations sometimes arise out of the congestions caused by venous obstruction (§ 298) and gravitation. Thus pneumonia (with hepatization, and sometimes suppuration) frequently occurs in connection with disease of the heart, impeding the circulation; in adynamic fevers, and in the sinking which precedes death, (§ 290.) The congestions of the lungs, brain, and mucous membranes, that result from the application of various asphyxiating causes, (§ 298,) sometimes end in inflammations, which become a chief source of danger after the restoration of the respiration, (§ 235, 243.)

404. Suppression of natural or habitual discharges, especially the catamenia, the sudden drying up of ulcers, and repulsion of cutaneous eruptions, (§ 69,) are recognized as causes of inflammation, (§ 67.) So far as the inflammation excited by these causes is in, or contiguous to, the parts previously affected, local irritation may have a share in producing it; but where it is in distant parts, it probably results from a congestion or local determination of blood, which belongs to the second class of causes just specified. Very probably some of these causes of inflammation have a twofold operation, that just specified, (producing a local fulness,) and that of local irritation by morbid matters introduced into the circulating mass of blood. Thus the visceral inflammations arising on the sudden healing of a suppurating wound may be promoted by local congestions resulting from the cessation of the purulent

discharge; but their circumscribed character, and the uniform event to which they tend, (suppuration,) seem to indicate a morbid matter in the circulating blood as the exciting cause of these inflammations. The same remark will apply to the inflammations of the skin, fauces, and mucous membranes in scarlatina, measles, and small-pox; the follicular enteritis of typhus,* and the visceral complications of erysipelas, and other specific febrile affections. In all these, besides a general tendency to internal congestions, we seem to trace the irritating operation of the morbid poison on particular parts.

405. We have noticed that sthenic hæmorrhages (§ 363) and fluxes, (§ 393,) if too speedily checked without sufficient reduction of the circulation, are apt to pass into inflammation. So likewise determination of blood, if it be long continued, may issue in inflammation, (§ 340.) The causes which excite determination of blood, when applied in a greater degree, or for a longer time, excite inflammation.

406. Before we proceed to examine into the nature of inflammation, we may properly inquire what is the mode of the operation of its causes. It is generally assumed that the first movement of inflammation, as of all pathological processes, is in the nerves; but this is by no means proved. That some causes of inflammation (irritants) operate first on the nerves, is probable from the following considerations. 1. Their action on the sensitive nerves is felt long before inflammation begins; thus the prick of a thorn in the skin, the smarting of caustic on a wound, the pain of the sting of an insect, are felt instantaneously; there is first nervous irritation; inflammation follows after. 2. The irritation is sometimes transferred to other parts by sympathy, of which nerves are the channels: thus strong irritants in the nostrils may cause inflammation of the conjunctiva, a carious tooth or a diseased bone may irritate and inflame parts which are not contiguous to it. 3. An injury to a nerve is sometimes followed by inflammation in parts connected with this nerve. Thus paralyzed limbs are liable to become inflamed. Lallemand relates a case in which a ligature, involving the right brachial plexus, was fol-

* I have observed an extraordinary development and inflammation of the isolated and grouped follicles of the intestines in the bodies of persons poisoned with arsenic. Their enlargement in epidemic cholera, and in the severe form of sporadic cholera and diarrhœa, caused by putrid effluvia, is well known. Are these glands excretory organs for the elimination of poisonous or noxious matters from the system? and in typhus fever, do they become inflamed and ulcerated by the continued operation of the poison in the exercise of this function? The favourable influence of moderate diarrhœa in fever, the uncommon fœtor of the stools, the general relation between the duration of the fever and the affection of these follicles, the salutary operation of mild mercurial remedies, which promote their secretion, and other facts that might be adduced, give so much countenance to this question, as to make it worthy of attention.

lowed by inflammation and suppuration in the opposite hemisphere of the brain.

407. On the other hand, the following arguments may be adduced to show that the nerves are not essentially the seat of the first part of the process of inflammation. 1. Some of the causes of inflammation (the majority of those inducing internal inflammation) produce on the nerves or nervous system no known primary effect, which resembles that of other causes of inflammation, (irritants:) thus inflammations excited by cold are often preceded by no marked nervous disturbance; whereas the strongest impressions of cold on this system are frequently not followed by inflammation, (§ 77.) 2. Inflammations often originate in congestions (§ 403) and in the sudden suppression of hæmorrhages and other discharges, (§ 405,) without the occurrence of any symptoms referable to the nerves: hence inflammations thus arising may escape detection, and are called *latent*. 3. Persons in whom nervous properties are thus developed, (§ 126, 152, 156,) are not those most susceptible of inflammation; and all varieties of nervous excitement are sometimes manifest in the highest degree without any inflammation ensuing. Even where pain and other nervous symptoms are excessive, and are the result of mechanical or chemical injuries, (such as crushed limbs, extensive burns, &c.,) inflammation sometimes does not follow; and this has led surgeons long to distinguish between irritation and inflammation. 4. Inflammation occurs in parts, the nerves of which are paralyzed or have been divided.*

408. Seeing, then, that inflammation is frequently excited without any obvious affection of the nerves, and is often not excited when nervous irritation is most intense, it may fairly be inferred that an impression on the nerves is not an essential part of the first process of inflammation. That the nerves are concerned in many ulterior phenomena of inflammation, and in its extension, is fully admitted; and in the case of excitement of inflammation by irritation, the primary operation of the exciting cause on the nerves has been already pointed out, (§ 406.) So far as is known, the blood-vessels are the essential seat of the whole process of inflammation, and although some of the exciting causes of inflammation (§ 402, irritants) act on the nerves as well, yet others (§ 403, as cold) operate chiefly and essentially

* It is maintained by Dr. Copland and others, that in these cases, branches of the ganglionic system, distributed on the coats of the blood-vessels, are the first subjects of excitement. This is a mere hypothesis, which gives no aid in the explanation of the phenomena, because nothing is definitely known as to the properties communicated by ganglionic nerves. Before the "influence of the ganglionic system" can be employed as an element in pathology, its existence must be proved, and its properties defined, in physiology: this has not been done.

only on the blood-vessels. Hence we find that the causes predisposing to inflammation (§ 401) are circumstances chiefly affecting the vascular system. A review of the exciting causes of inflammation (§ 402, 405) will show that in their mode of operation on the blood-vessels they may be divided into two classes: 1. those that cause determination of blood, (§ 322, 324;) and, 2. those that produce congestion, (§ 290, 299.) The former class comprehends all irritants, (§ 402;) the latter class includes cold and other agents, which directly produce congestion, (§ 403, 405.) We have several times had occasion to mention that determination of blood, when exceeding certain limits, is apt to pass into inflammation, (§ 340;) and that local congestions are liable to be converted into inflammation, (§ 292, 293, 306.)

PHENOMENA AND NATURE OF INFLAMMATION.

409. Having noticed the causes of inflammation, and traced their essential operation to be on the blood-vessels and their contents, we have next to inquire what is the character of their operation on the vessels, and what phenomena it develops.

That the blood-vessels are enlarged in an inflamed part is very obvious from the increased redness manifest to the naked eye. But in what respect does inflammation differ from congestion, in which also the vessels are enlarged? It differs not only in the accompanying symptoms and in its products, but also in the observed condition of the vessels of the part. Thus besides greater pain and heat in an inflamed part, and earlier and more abundant effusions into or from it, the more florid hue of redness, the strong beating of the arteries leading to the part, and augmented quantity of blood flowing from its veins, clearly indicate that there is increased motion of the blood, instead of diminished motion, as in congestion, (§ 287.)

Common observation of the pulse of arteries leading to inflamed parts would suffice to show that there is determination of blood to them; and some experiments performed by Dr. Alison and others have directly proved that these arteries are enlarged.* It was found that the arteries leading to an inflamed limb in a horse were considerably larger than those of the sound limb. John Hunter had arrived at the same conclusion from experiments on the ears of a rabbit. Now this enlargement has been before traced to diminished tonicity in the affected arteries, and this was found to be the chief instrument in causing determination of blood, (§ 326, 327.)

That the motion of the blood is increased through an inflamed

* Trans. of British Association, 1835.

part, is distinctly proved by the observation of Mr. Lawrence; venesection being performed at the same time, and in the same manner, in both arms of a patient with inflammation of the hand, a much greater quantity of blood flowed from the vein of the arm of the inflamed hand than from that of the other arm.

410. It is certain, both from the preceding facts, and from direct observation under the microscope, that determination of blood is present in inflammation. The vessels in the vicinity of the inflamed part are the channels of an increased flow, there being a flux of blood to the whole inflamed part, and through some of its vessels. But if this were all, there would be no distinction between determination of blood and inflammation; yet the greater redness and swelling and peculiar character of the effusion point out that inflammation is not mere determination. Microscopic research has established one great point of difference. The observations of Thomson, Hastings, Kaltenbrunner, and Marshall Hall, have long clearly proved that there is no more or less *obstruction* to the passage of the blood in the vessels most inflamed. Thus in the frog's web, when a part inflames from local irritation, the blood is seen to move more slowly in the part most irritated, and gradually accumulating in the vessels, renders them larger, redder, and more tortuous, until the motion ceases altogether in them, whilst neighbouring vessels are still the channel of an increased current. A chief point then in which inflammation differs from determination of blood, is in the retarded or arrested flow of blood in some of the vessels. This answers to the definition which we have given of inflammation: *too much blood in a part, with motion* (*of that blood*) *partly increased, partly diminished,* (§ 399.)

411. The question now naturally arises—What is the cause of the obstructed or retarded flow of blood through an inflamed part? This has ever been the chief difficulty in the pathology of inflammation; and it is especially to solve this that various hypotheses have been framed. Thus Cullen supposed a spasm of the extreme vessels to be the cause of obstruction, and therefore the proximate cause (§ 13) of inflammation. Dr. Wilson Philip ascribes the same obstruction to a weakness of the capillaries, which he presumes to incapacitate these vessels from transmitting the blood. John Hunter considered that there is something more active and vital in the enlargement of inflamed vessels, and he applied to it the term "active dilatation." The analogous expressions, "vital turgescence," "turgor vitalis," "inflammatory erection," used by Kaltenbrunner and other German writers, imply a similar notion.

The hypothesis of Cullen is quite inconsistent with direct observation, the extreme vessels being seen under the microscope to be in a state of dilatation, not of spasm. This observation corresponds better with the idea of Dr. W. Philip, which was indeed founded upon it: but it has been objected by Dr. Marshall Hall and others, that the capillaries, by their contraction, do not aid in the circulation of the blood, and that their "debility" therefore cannot be a sufficient cause for interrupted passage of blood through them. The words used by Hunter scarcely convey any explanatory meaning. They may be interpreted to assume the existence of a self-expansive power in the vessels, which power is supposed to act in inflammation as well as in natural formative or plastic processes in the animal body. But the existence of such a power is quite at variance with all that is known of animal physics. A part may be expanded by elasticity, or by the injection or retention of fluid in it, but no direct vital expansile power has been ever proved to exist. The apparently active expansion of the heart in its diastole may be ascribed to the natural elasticity of the organ and the increasing weight of its contents, suddenly enlarging its size on the cessation of its antagonizing systole: neither its structure nor its mode of action countenance the notion of a vital dilating power.

412. Haller and some of his followers ascribed the circulation of the blood in part to certain supposed properties of vital attraction and repulsion, by which the blood is drawn into, or repelled from, particular parts, independently of all motion of the living solids. These opinions have been recently advocated with much ability by Dr. Alison, who considers changes in the vital attractions and repulsions to be the chief elements in the process of inflammation, as well as in other pathological conditions in which the blood and its vessels are mainly concerned.* This

* See "Alison's Outlines of Pathology and Practice of Medicine," 1843, p. 122. Several of Dr. Alison's arguments in favour of the existence of "vital attractions and repulsions" are founded on certain physiological facts, which he considers inexplicable in any other view. It belongs properly to works on physiology to discuss these matters; but I must own that none of these arguments seem to me to be satisfactory. The motion of the sap in the chara and other vegetables may be well explained on the principle of exosmosis and endosmosis. A fluid of lower density, (water,) physically tends to penetrate and pass into membranous tubes, containing a liquid of greater density, (sap:) that which begins a flow into the tubes may sustain it in a continued current through them so long as the difference in density subsists between the water and sap. A similar principle doubtless aids in many cases the motion of fluids in the animal body, but many motions of fluids observed in animals (as in the air-tubes, genito-urinary passages, &c.) have been traced to the vibrations of cilia, and are no proof of the existence of vital attractions and repulsions.

It is said that when an artery is tied, the blood ceases to run into the open part of it, and passes away by adjoining branches, which become enlarged in proportion, whilst the tied portion becomes empty. It has been supposed that the blood here spontaneously leaves the part of the artery through which there is no passage. I demur to the correctness of the statement, and still more to the explanation. Every one who has witnessed great surgical operations must have no-hypothesis needs the most ample proof before it can be received. It assumes the existence in the fluids as well as in the solids of the living body, of properties as distinctive and as peculiarly vital as that of contractility or sensibility. It ascribes to these fluids and solids powers of attraction and repulsion at *sensible* distances, like the attractions and repulsions of electricity, magnetism, or gravitation, yet distinct from all these, and sometimes opposed to them. It attributes to the living body a new physical power, and almost a discerning intelligence in the exercise of that power. Now, before the existence of such a power can be admitted, it must be proved that the phenomena of living structures are not and cannot be explained through any known vital or physical agencies. We have already adduced and referred to arguments and observations to show that the *known* physical and vital properties of the living body will account for the chief phenomena of health and disease; and we have now to consider whether the same thing may be done with regard to inflammation. If we succeed in explaining the nature and effects of inflammation by a reference to ascertained properties, it will be needless and unphilosophical to assume the existence of others, which are mysterious and unknown.

413. We have before stated (§ 408) that inflammation may originate either in determination of blood, or in congestion, and we now proceed to show that inflammation essentially comprises both these morbid elements. The mode in which the process of

ticed the strong pulsation above the ligature of tied arteries; and the occasional occurrence of secondary hæmorrhage shows that the blood has no inherent disposition to pass in a new direction. No doubt in time the artery ceases to receive blood into its tied portion; but this is because either a coagulum is formed where a current cannot pass, or the tonicity of this portion effects the contraction of the tube, the force of the circulation being diverted into the contiguous enlarged branches. Here is no proof of any self-motory and self-directing power in the blood. I have before stated that all my own microscopic observations have failed to detect in the blood any spontaneous motions, independent of contractions of the solids or of currents caused by ciliary motion, exosmosis, and endosmosis, and such physical causes. The oscillatory motion said to have been seen by Haller and Kaltenbrunner in the small blood-vessels of inflamed parts, "even after the heart is at rest," may, perhaps, be ascribed to the tonic contraction of the arteries, which, although gradual in itself, is often seen to act by jerks on partially obstructed vessels. A similar oscillatory movement is sometimes communicated to capillary vessels by the quivering contraction of adjoining muscles. Another observation of Haller mentioned by Dr. Alison, that of "blood escaping from vessels between the layers of a living membrane, and nevertheless pursuing its course in a regular stream for a time, even against the influence of gravity," may be fairly referred to the vis à tergo from the open vessel. In the fluids of such a nicely adjusted hydraulic apparatus as the vascular system of animals, and even vegetables, it is surprising how readily motions may be produced by various physical causes; and when these motions are magnified by the microscope, it is not wonderful that they should have been mistaken for vital movements of the blood itself.

inflammation has been chiefly studied, is by observing under the microscope the effect of irritants on the frog's web. It must be remembered, however, that this is only one mode in which inflammation may begin, and we shall afterwards find that cold-blooded animals fail to show some of the most remarkable results of inflammation.

The effect of weak irritants on the vessels of the frog's web has been described before, (§ 294, 326.) We then found that irritation may cause first determination of blood, then congestion; these results being dependent on an enlargement respectively of the arteries and of the veins. But if a strong irritant (as a grain of capsicum, or a minute globule of essential oil*) be applied to the web of a frog, all the blood-vessels speedily become enlarged: those most irritated are very large and red, and the blood in them is stagnant and coagulated: contiguous vessels are also very large, but less red, and the motion of the blood in them is slow, and often in pulses or oscillations; whilst in vessels beyond, the enlargement of the capillaries is less considerable, and the current of blood is very rapid.

Now, it is obviously the stagnation or tardy motion of the blood in the most enlarged capillaries, in the midst of surrounding increased flow, that most characterizes inflammation; and we have still to inquire what is the cause of the stagnation. This cause must be either in the vessels, or in their blood, or in both. The latter we shall find to be the true case.

414. We have already pointed out (§ 300) that atony and flaccidity of blood-vessels may become a cause of impediment to a current through them, not by preventing these vessels from actively contracting on their contents, (for they have no such power,) but by removing that tone by which the vessels maintain the calibre and the tension best calculated to transmit onwards the force of the current. Vessels thus weak and inelastic, instead of equably conveying the current, become distended, lengthened, and tortuous in receiving it; and by their very mass, as well as by their inelasticity, they partly break the force of the current, and partly turn it into other channels. The mode in which this results in inflammation will be better understood, if we review other local modifications of the circulation in comparison with it.

In determination of blood, the arteries are enlarged, and so are the capillaries in due proportion; the circulation is therefore equally increased. In congestion, the capillaries are enlarged, without any increase of the arteries: the motion is therefore impaired; but still, being gentle, it may diffuse itself through the mass, which moves slowly. But if to congested capillaries there

* These are preferred because they produce no chemical change in the parts.

be added the increased and abrupt force of the current from enlarged arteries, or if to determination of blood (enlarged arteries, § 326) an atonic congestion of the capillaries be joined, the propulsive power of the current will be impaired. As in the experiment with the intestine, (§ 300,) the blood will pulsate or oscillate in the distended vessels rather than pass through them; and the main current will pass through collateral anastomosing channels, which become the seat of simple determination or increased flow. This is just the state of things in the incipient stage of inflammation; and if either the capillaries do not speedily recover their tone, or the arteries do not contract, the blood in parts becomes stagnant, and coagulates, and the obstruction is confirmed. The arterial portions of some of the obstructed capillaries are still open, and exposed to the pulsative force from the supplying arteries, which continues to strain their coats, and cause an oscillatory motion of their blood particles, but no passage through them. Such are the phenomena which we see under the microscope.

It may, then, be fairly inferred, that one cause of the stagnation or retardation of the blood in an inflamed part, is a weak, inelastic state of the capillary vessels;* such, in fact, as exists in cases of atonic congestion; and on referring to the causes of inflammation, (§ 304,) it may be perceived that many of them act by first producing congestion. Nay, we have found (§ 294) that even irritants, in some measure, operate in the same way. "The continued application of stimuli to a part is sometimes followed, not by inflammation, but by congestion. This especially happens in the liver, a chiefly venous organ; but it occurs also in other parts. It might be supposed that the stimuli act by exhausting the contractility of the small vessels, and thus leaving them weakened and distended by their contents. . . . . But on the application of a strong stimulant, such as a minute drop of essential oil, the previous arterial contraction is not apparent, and the enlargement is speedy and obvious, causing extreme rapidity of motion and enlargement in all the vessels. In a few minutes, the size of the arteries begins to diminish, and with it the motion in the capillaries beyond them. Many of the capillaries still re-

* It may, perhaps, be objected that I have supposed a similar state of the arteries to be the cause of an increased flow through them, and to be the physical cause of determination of blood. But this is no objection. The arteries, as compared with the capillaries, are few in number; their current is rapid; they are nearer to the source of power, and are easily supplied from it; when their coats lose some of their tone, the pressure of blood into them serves to stretch them to tension, and they present even less obstacle to the flow. In capillaries, on the other hand, the force is so much distributed, that it is easily disturbed, and the motion, naturally tardy, is readily arrested.

tain their enlarged dimensions; in them the motion is most sluggish, and, in some parts, ceases altogether."*

415. But it is very certain that the obstruction, and much of the other features of inflammation, are greatly dependent on changes which take place in the blood within the inflamed vessels. J. Hunter did not overlook this; and, besides describing the coagulation of the blood in the most inflamed vessels, he mentions the adhesion of fibrin to their interior. The coagulation of the blood in the inflamed vessels was also noticed by Gendrin, and others; and Dr. Marshall Hall attributed the obstruction of the vessels in inflammation to the adhesion of blood-globules to the walls of the vessels. It appeared to me, that microscopic observation ought to be directed to this point more specially than had hitherto been done; and in 1841, I made many careful examinations of the early stage of inflammation in the frog's web. Some of the results were published in the Medical Gazette of July of that year; and as they have been confirmed by several other observers, it may be proper to describe them.

Poiseuille, in his observations with regard to the motionless layer of serum which intervenes between the moving blood and the walls of blood-vessels, had noticed that the blood particles sometimes get into this still layer, and either remain fixed there, or move onwards more slowly than the rest of the blood. In repeating this observation, Mr. Toynbee and myself remarked that it was not the red particles, or elliptical blood discs, that thus adhered to or slowly rolled along the sides of the vessels, but the white or colourless globules, (§ 212,) called by Müller, lymph globules. "I have never seen a solitary elliptical disc adhering to the sides of a vessel; and whenever one was arrested in its course, it was from its becoming hitched by one or more of the adherent round globules. But what appeared to me most remarkable with regard to these white globules, was the great difference in their number under different circumstances. In young frogs, and in those much subjected to experiment, they are always present; but in healthy adult frogs, placed under the microscope with as little handling of the web as possible, there were few or none to be seen. I have watched, for ten minutes at a time, without seeing one: the motionless layer was very thin, but clear, and all the blood particles in the larger vessels seemed to move at the same rate of speed." It is under these circumstances that the effect of irritation or mechanical injury was best seen. "By pressure of the finger on the web, partial stagnation was produced in many of the vessels; and when this yielded to the returning current, the walls of the vessels were seen studded with the white

* Gulstonian Lectures for 1841; Med. Gaz., July 16, 1841.

globules; whilst many others of the same kind rolled over them slowly in the direction of the current. I have before mentioned (§ 294,) that a similar result ensued after the web had been stimulated by capsicum or an aromatic water. Even in the rapid flow of blood following these applications, minute globules could be seen creeping slowly along the transparent outline of the larger vessels; and as the arteries contracted, and the flow through the other vessels became less rapid, the number of these globules increased, their motion became slower, and many adhered to the sides of the vessels. If the stimulus used was rather strong or long applied, the number of sticking globules was so great as to prevent the red particles from passing; and these becoming impacted in increased numbers, gave to the obstructed vessels a uniform and deeper red colour. When the stimulation was moderate, and equally applied to the web, the stagnation usually took place first in some of those anastomosing veins in which the current is naturally slow and varying in direction; but when a stronger stimulus (as an essential oil) was used, the stagnation speedily ensued at the point of its application; in fact, unless very minute quantities were employed, the stagnation was almost immediate and extensive."*

416. I have varied these observations in a great many ways, and have always found considerable or continued irritation of the vessels in the frog's web to be attended with the appearance and adhe-

* Med. Gaz., July 23, 1841. I have only recently read a paper by Mr. Addison, of Great Malvern, published in the Med. Gaz. of Jan. 29th of the same year, in which some of the same appearances had been described before I made the above observations. The following description is given by Mr. Addison:—"In the frog's web, two days after the application of *salt*, in some of the larger capillaries or smaller veins, there are a great number of globules, No. 3," (lymph globules;) "and it is quite extraordinary to observe the difference in movement between these round speckled globules and the oval ones; the blood globules pass in a continued stream, while in the same fluid, in the same vessel, are a great multitude of other (lymph, No. 3) globules, which do not move, or do so very sluggishly: every now and then they move slowly, apparently urged on by the repeated knocks they receive from the blood globules. It would appear, that after the capillary vessels have been acted on by the salt, that the round (lymph) globules accumulate in an unusual manner, and the blood globules repeatedly slide over and knock against them. In some of the vessels, there is a rapid stream of blood in the centre, whilst at the circumference there are many stationary, round, spotted globules, which do not obey the impulse which urges the stream of blood, but remain, or move on slowly by little starts, at uncertain intervals, and with unequal pace." This account corresponds very exactly with what I have myself observed; but I should not consider the experiment quite conclusive with regard to inflammation, inasmuch as the chemical action of the salt might have been concerned in the production of the lymph globules, as salt seems to generate granules in the blood liquor. In my observations, I was careful to use no stimulus which has any known chemical action on the blood. The greater prevalence of lymph globules in the motionless layer had been noticed by Wagner and others; and their more abundant production in an inflamed part has been mentioned by Mr. Gulliver.

sion of the colourless globules; and that when the irritant used is at all strong, or frequently applied, many vessels become totally obstructed, appear larger and redder than before by the accumulation of red particles in them, (the blood liquor having passed on,) and exhibit to the naked eye all the appearance of inflammatory injection. The chief cause of obstruction seems to be comprised in the two circumstances—the increased production of the white globules, and their remarkable disposition to adhere to the walls of the vessels and to one another; each of these circumstances must be noticed.

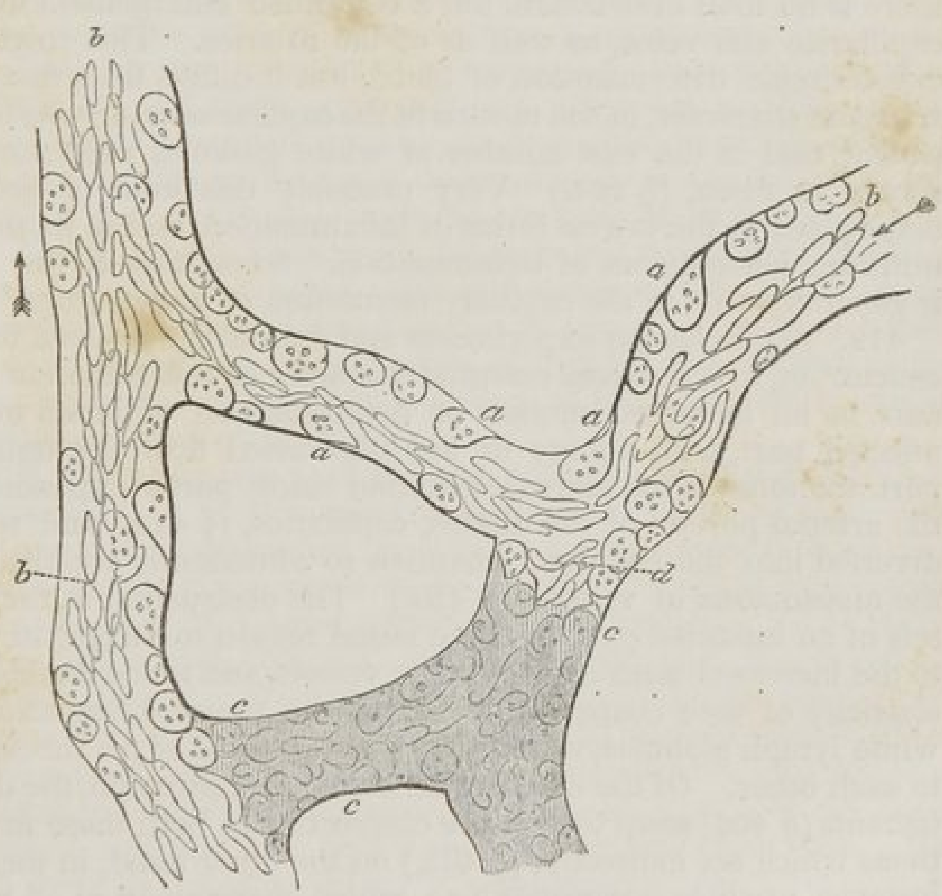
The origin of the white or lymph globules seen in the blood is involved in some doubt. They are distinctly spheroidal bodies, of a gelatinous consistence, and composed of granules, some of which contain nuclei. According to Mr. Addison,* they are invested by a delicate membrane, constituting a compound nucleated cell, which slowly by the action of water, more speedily by the operation of solution of potass, bursts and discharges granules and molecules, (nuclei and nucleoli.) In this respect, they differ from the blood-discs, which are speedily burst, and are almost dissolved by either of these fluids. Dr. Martin Barry has endeavoured to prove their identity with the nuclei of the red blood-discs; but whatever be their origin or destination, in the frog and toad they bear no resemblance to any part of the blood-discs, differing altogether in form, colour, and consistence. Mr. Gulliver has remarked the same dissimilarity between the white and blood particles in the dromedary, lama, and other camelidæ, and in birds, in which the blood particles are elliptical. It would seem more probable that they are formed in the plasma, or blastema of the liquor sanguinis itself; but whether they grow from previously existing molecules or granules, (Addison,) or are formed quite spontaneously, cannot now be decided. The suddenness with which they may be produced by irritation or mechanical injury to the web of the frog, would scarcely comport with the notion of growth, or of their being always enclosed in a cell. The presence of these globules in great abundance, in inflamed blood, has been noticed by Gendrin, Gulliver, and others. Mr. Addison has particularly observed them in the buffy coat, (§ 208,)† together with numerous bodies of much smaller size, (granules and molecules.)‡

417. The peculiar disposition of the white globules to adhere to the walls of the vessels is remarkable, and might seem to be a vital property. But there are some circumstances which countenance the notion that it is chiefly physical. The reason why the red particles are more readily carried in the stream appears to

* Trans. of Provincial Med. and Surg. Assoc., 1843, p. 240.
† Med. Gaz., Dec. 1840. ‡ Provincial Trans., 1843, *loc. cit.*

be, that they expose a large surface to the current; and being covered by a perfectly smooth, unadhesive membrane, they are not liable to stick to the walls. The white globules, on the other hand, are more compact; and although, when in the current, are readily carried by it, when more out of it, and in the motionless layer, are merely rolled by it, like pebbles by a rapid stream. Further, they manifest a distinctly adhesive property, which causes them to stick to the walls of the vessels.* In this respect,

* The accompanying diagram exhibits the appearance of a small portion of the capillaries of a frog's web after the application of a grain of capsicum. The elliptical blood discs (*b*) are running in the axis of the vessel, which is much narrowed by white globules adhering to the walls, or only slowly rolling along them. These globules are speckled with nuclei or granules, refract the light strongly, and when rolled on by the current, some of them become pear-shaped from their sticking to the vessel, thus forming a kind of dragging tail, seen very well on those marked (*a*); on altering the focus, globules may be seen adhering to the other parts of the vessel. The shaded portion (*c*) is totally obstructed with lymph and blood particles, so impacted together as to form a homogeneous red mass. In such a case I have often seen the particles at (*d*) exhibit a pulsating or oscillatory motion, (corresponding with the action of the heart;) and this, after a time, succeeds in breaking down the obstructing mass, which passes away in clots, leaving the vessel (*c*) studded with lymph globules like the other.



they contrast remarkably with the red blood-discs, and the newly formed globules of irritated vessels seem to have this adhesive property in the highest degree: they are probably without a covering.

418. It seems, then, to be well established, that an essential part of inflammation is the production of numerous white globules in the inflamed vessels; and that the obstruction of these vessels is mainly due to the adhesive quality of these globules. The production of these globules must probably be considered as an ultimate fact in the history of inflammation and nutrition; but it may be observed, that sometimes it seems to be the direct effect of an irritant acting on the blood-vessels and their contents, (§ 415;) in other instances, it seems rather to result from determination of blood into previously congested capillaries, (§ 414.) Any circumstances causing continued determination of blood, where congestion is already present, will occasion the production of the white globules, and, consequently, inflammatory obstruction may ensue. The complete obstruction of some capillaries by coagulation takes place in all cases of severe inflammation of the frog's web; but there are slighter kinds of increased vascularity, in which there is no total obstruction, but a continued enlargement of the capillaries and veins, as well as of the arteries. This might be called simple determination of blood; but it differs from that of a transient character, in the motion in the capillaries and veins being slower, and in the vast number of white globules seen moving slowly in them, (§ 294.) Very probably this kind of process takes place in the lowest forms of inflammation, and in increased nutrition independent of inflammation. Something of the kind is generally seen in the capillary circulation of young frogs.

419. The foregoing experiments and considerations lead to the conclusion, that the most essential character of inflammation consists in an increased motion or determination of blood to the affected part, with a more or less obstructed flow through the part: the force of the increased motion being partly expended in the arterial portion of the dilated capillaries, (§ 414,) and partly diverted into the collateral channels so abundantly supplied by the anastomosis of vessels, (§ 410.) The obstruction in the vessels of an inflamed part we have found reason to ascribe in part to the increased mass in the smaller vessels, and to the diminished elasticity of their coats; and in part to the unusual formation of white lymph globules, which adhere to the walls of the tubes, and to each other. Of the exciting causes of inflammation, the direct irritants (§ 402) seem to produce obstruction in both these modes; those which act indirectly, (§ 403,) on the other hand, in the first instance produce congestion—to which determination of blood being subsequently added, the inflammatory process begins: hence

the latter causes, although very common, are not sure of exciting inflammation as direct irritants are.

420. The effect of these changes, essential to inflammation, is, to expend much of the circulating force conveyed by the arteries on their capillary terminations; and the enlargement and tortuosity of these capillaries, the production of globules which adhere to their sides, and their total obstruction by the same means, seem to be so many progressive expedients used by nature to direct the force of the circulation to that part of the vessels by which the process of reparation and nutrition is chiefly carried on. This leads us to consider the further changes effected by inflammation.

421. We have already found that an inflamed part is the seat of determination and of congestion or obstruction. It is this combination which leads to the changes which characterize inflammation, and which, in extent and variety, exceed the changes from any other kind of hyperæmia. The determination of blood to and near the obstructed vessels is attended with the usual results of determination, (§ 333, &c.;) but to a greater extent than usual, because the cause of determination is more permanent. The congestion or stagnation has also its effects, (§ 303, &c.;) but more marked and peculiar than usual, because the obstruction is more complete than in congestion in general, and because it is modified by the influence of a continued force of blood acting against it. All these circumstances point out that the natural functions of the vessels must be much modified by inflammation, and this in different modes in different parts of the inflamed site. Thus, in the vessels which are the channels of an increased flow, the functions will be more or less exalted or excited; whilst in those that are obstructed, vital properties will be more or less impaired. It is the approximation of two such opposite conditions, excitement and interruption of living actions almost in the same spot, that render inflammation so seriously destructive to structure as well as to function.

422. Inflammation at first much exalts sensibility (§ 133) and contractility, (§ 111;) causing tenderness, pain, and spasm. But the obstructed circulation may cause a suspension of these properties (§ 273) in the centre of the mischief, whilst in surrounding parts, the seat of determination, they are exalted. The sympathetic relations (§ 152, 156) of the inflamed part are also commonly increased. Natural secretions are either suspended by inflammation, or modified by the addition of various modifications of the serous and albuminous parts of the blood. This involves the change of nutritive secretion, which is so important and early a part of inflammation, that it must be noticed more fully. We shall recur to the other effects of inflammation under the head of symptoms.

423. The effusions from inflamed vessels at an early period are much the same as those from tense congestion (§ 305–8) and determination of blood, (§ 340, 1;) but they commonly occur in greater abundance, contain more animal matter, and, as the inflammation advances, they sometimes present appearances not met with in the products of mere congestion or determination. Thus the effusion at first is a thin serum, causing swelling in complex textures, accumulating in the dependent parts of serous cavities, or diluting the secretion of the more simple mucous membranes. But soon fibrin is also effused, part of which may concrete into coagulable lymph, or still remains dissolved, as in the liquor sanguinis. Thus an inflamed pleura becomes coated with a film of lymph; and the clear fluid effused into the sac, when removed from the body, sometimes spontaneously separates into a fibrinous clot and serum. This occurring in complex textures gives a hardness to their swelling, as in phlegmon of cellular membrane, hepatization of the lung, &c. In mucous membranes, there may be thickening of the submucous texture, and the mucous secretion becomes unusually viscid.

424. The microscope has given much additional information on the nature of inflammatory effusions, although it has yet left many points in uncertainty. In the frog's web, after inflammation has continued some hours, there appear outside of the vessels (especially those in which the strongest current encounters the most complete obstruction) white globules or corpuscles, with specks in them, exactly like the lymph or nucleated globules within the vessels, (§ 415.) These are also found in various inflammatory effusions, and are called *exudation globules* or *fibrinous globules*. Mandl supposes them to be merely consolidated globules of fibrin, and states, that the liquor sanguinis may be seen to coagulate in similar globules on the glass of the microscope. But these have been described by Gerber as mere albuminous granules, without nuclei, and quite unlike the true exudation corpuscle. So, also, from the recent observations of Mr. Gulliver* and Mr. Addison,† it appears, that fibrin consolidates in extremely fine threads or fibrils interlacing each other. Both these observers describe the nucleated or granulated corpuscles as occurring among these fibres, together with more minute granules and molecules, (nuclei and nucleoli,) which appear to be similar to those which compose the corpuscles. Now, all these bodies appear in inflammatory effusions, although they occur in very various proportions, and present different modifications. The following are the chief of these elementary solids of inflammatory effusions.

* Note to Gerber's General Anatomy, p. 31.
† Med. Gaz., April 15, 1842.

1. *Molecules*, immeasurable from minuteness, each appearing as merely a dark speck. (*Smaller primitive molecules;* Gruby.)

2. *Granules*, (Gerber, Addison,) measuring from $\frac{1}{12000}$ to $\frac{1}{8000}$ of an inch, appearing as a light spot, surrounded by a dark circle. (*Larger primitive molecules*, Gruby. *Disks*, Barry.)

3. *Fibrils*, extremely fine, forming the chief solid of fibrine, and the buffy coat of the blood.

4. *Lymph or exudation corpuscles*, measuring from $\frac{1}{6000}$ to $\frac{1}{700}$ of an inch, (Gulliver,) composed of granules and molecules, (nuclei and nucleoli,) and sometimes enveloped in a cell.

Pus globules appear to be enlarged modifications of the last; and so are globules of mucus, and which, with nucleated epithelium particles, are commonly found in the effusions from mucous membranes. *Yellow tuberculous* matter has been distinctly proved by the researches of Gerber, Gulliver, and Addison, to consist of disintegrated or degenerated exudation corpuscles, or granules.

425. Of these elementary solids, the fibrils certainly may form from the effused liquor sanguinis out of the vessels, and even removed from the body, (Addison;) but it is a question whether the others concrete spontaneously from the liquid fibrin, or grow from germs, (molecules or granules,) disseminated from the vessels or adjoining textures. The close resemblance of the exudation corpuscles and their contents to the white globules and granules, so abundantly produced in the blood of the inflamed vessels, would seem to indicate their identity; but it is not easy to understand how they pass through the walls of the vessels, in which no pores are visible under the highest magnifying powers. Mr. Addison has, indeed, represented the white globules as first passing into the substance of the wall of the blood-vessel, and then beyond it; but this would seem too slow a process. It would appear more probable either that nuclei or molecules, too small to be discernible, do pass out in this way, and then grow and propagate compound granules, (lymph and pus corpuscles;) or that these corpuscles are formed by coagulation in the effused liquor sanguinis as the fibres of fibrin certainly are.

426. These solid products of inflammation, when they cohere and grow into nucleated cells and fibres, are the plastic materials of which new membranes and textures are formed: when they remain detached, and swell into larger globules, or split into irregular granules, or cohere imperfectly and shrink without developing cells, they form the aplastic materials of purulent, tuberculous, and kindred products, which Gerber therefore calls "degenerated exudation corpuscles."* As we shall have to

* This statement, which is founded on the recent microscopic observations of

notice these further under the head of results of inflammation, we shall now return to the process of inflammation and its accompanying phenomena.

427. Inflammation is always attended with more or less effusion. Where the inflammation is slight, this effusion may remove it by unloading the engorged blood-vessels; but where the inflammation is more intense, that is, where the obstruction is considerable and the determination of blood strong, the effusion may go on to a great extent without resolving the inflammation. It is then that the more serious effects of inflammation result. The effused matters press on and pervade the adjoining textures, injure their nutrition, and impair their cohesion; and thus takes place the *softening* of textures, which occurs chiefly in those of a complex kind, which retain the effused matter. The continued obstructions in the inflamed part leaves the veins and lymphatics free to absorb, and the high pressure and determination of blood tend rather to promote this process of absorption. Hence, as new matters are effused, the old texture is compressed, disintegrated and absorbed; the finer exudation corpuscles and fibres themselves are removed or altered, and the large pus globules alone remain: this is *suppuration*. Or if the original obstruction of the inflamed vessels be extensive, or have been rendered so by the subsequent effusion, the supply of blood may be so stopped in a part, that it dies, and the dead part may then either be only dissolved and absorbed at its circumference, and separated from the living textures in form of a *slough;* or if more extensive, the dead part may pass into decomposition before it can be separated, and thus occur *gangrene* and *sphacelus*. If the inflammation be of a lower kind, the obstruction less complete, and the effusion more gradual, the nutrition of the natural texture is only impaired, not arrested, and from the increased deposition of solid matter, *induration* or *consolidation* takes place.

SYMPTOMS AND EFFECTS OF INFLAMMATION.

428. We have described the process of inflammation in its intimate nature and phenomena; we have now to notice its more obvious effects on function and structure, which become symptoms of its existence. These symptoms may be divided into

Gerber, Gulliver, Addison, Watt, and others, is a remarkable confirmation of views on the nature of pus and tubercle which I have entertained for the last twenty years, and to which I adverted in the following sentence, published fifteen years since:—"I am myself disposed to consider tubercular matter, pus, and coagulable lymph, only as varieties of the same albuminous matter that exists in the blood, and differing from each other rather in mechanical condition and consequent capability of organization, than in chemical composition."—Rational Expos. of Physical Signs of the Diseases of the Lungs and Pleura. 1828. p. 159.

local and general; the local occurring chiefly in the part which is the seat of inflammation; the general affecting the system at large.

LOCAL SYMPTOMS.

429. We have before remarked that the local symptoms are commonly more prominent, and the first to occur, when inflammation is excited by local irritation, (§ 402,) and the fever which afterwards supervenes may even disguise the local symptoms. The chief local symptoms have been already mentioned in the definition, *redness, heat, pain, and swelling*, to which may be added various disturbances of the function of the part affected. We shall explain and illustrate these symptoms.

430. The *redness* of an inflamed part is obviously due to the increased quantity of blood in the vessels. All these vessels are much enlarged, so that they receive many more red particles than usual; and the finest capillaries, which commonly are invisible from their admitting only the liquor sanguinis with now and then a red particle, are now distinctly coloured from the number that pass into them. Some observers have thought that new vessels are formed by the blood forcing its way through the textures. I have never seen this in the frog's web; but it appears to take place in some textures which are not naturally vascular, such as the anterior part of the cornea, and cellular cartilage, (Toynbee.) But the microscope shows that besides the augmented size of the blood-vessels which convey blood, much of the redness of inflammation arises from the vessels in which the blood is stagnant. The colour of these is much more red than that of the vessels through which a current still passes; and this has before been referred to an accumulation of colouring matter, which takes place in them, (§ 415, 417, note.) These vessels appear so impacted to their outmost limits with colouring matter, that the shape of the blood-disks and of the white corpuscles is no longer discernible: yet these are still present; for when an obstructed vessel re-opens, the red mass breaks up into clots and particles, and many white corpuscles are left sticking to its walls. (See *note*, p. 215.) It is obvious, therefore, that the obstructed vessels become stuffed, as it were, with red particles, the liquor having passed on. In many instances, too, it may be seen that the redness of an inflamed part is augmented by spots and patches of extravasated blood, which prevail especially in some varieties of inflammation.

The redness of inflammation presents great varieties according to the number and distribution of the capillary vessels of the part; but its most essential seat being in the capillaries, its most constant character is a diffused or capilliform redness. This is commonly far more vivid and general in the living than in the dead body. In the skin and mucous membranes during life, it is often seen as a uniform blush of colour, varying from a delicate pink to a bright crimson. After death this blush has sometimes entirely disappeared; but commonly more or less of it remains; and on examination with a lens, it is found to consist chiefly of numerous vascular striæ, network, or points, with here and there larger vessels and ramifications also injected. But the large vessels (veins) are distended much less generally than in congestion, (§ 280,) and the redness is therefore less arborescent and ramiform. To explain the reason of the disappearance of inflammatory redness after death, we must bear in mind that much of it depends on determination of blood, (§ 326,) which is maintained by the action of the heart, distributed by the arteries; and that when this ceases in death, the tonic contraction of the arteries, which survives for a few hours, expels the blood from the vessels, (§ 120.) A similar effect is sometimes produced during life, by cardiac syncope. The redness that remains after death seems chiefly to consist of the vessels which have become totally obstructed and impacted with blood, or have long congested and have lost their tone, (§ 295.) This furnishes us with a useful means of distinguishing in different cases the comparative prevalence of the elements of inflammation. Thus in cases in which the redness disappears after death, we may know that the predominant element was local determination of blood (§ 409) without much obstruction or permanent congestion. This is observed in erythematic and diffused membranous inflammations, the cutaneous inflammations of eruptive fevers, and the early stages of all inflammations excited by moderate local irritation, (§ 402, 415.) On the other hand, if much redness remains after death, we may infer that obstruction or congestion of the vessels has existed to a great extent. This happens especially in phlegmonous inflammations, those of parenchymata, and others which have advanced to a certain intensity, and those which have originated in congestion, (§ 403.)

The florid hue of the redness is also during life a sign of the predominance of determination, for it shows that the blood is chiefly arterial and not stagnant. Where congestion prevails, or where the blood has been long stagnant in many vessels, the colour is deeper; but it is rarely so deep as in pure congestion, for the presence of white globules tends to lighten it or give it a brownish tinge. In the dead body these distinctions are not equally available, for the arterial part of the blood may have been removed by the contraction of the vessels, or darkened by stagnation; and the livid portions speedily become florid on exposure to the air.*

The progress of inflammation modifies the redness. The colour becomes more florid and deeper as the inflammation advances to its acme; it then becomes either livid before it subsides, or paler from the colour of the effusion. In complex textures, the effused lymph or pus changes the redness to pink, flesh colour, drab, or yellow.

431. The *heat* of inflammation is obviously dependent on the increased flow of blood through the part; and it may be considered the representative of the amount of determination of blood concerned in the inflammation. Hence it is great in extensive and active inflammation, and is generally proportioned to the florid redness or arterial vascularity. It is uncertain whether the high temperature of an inflamed part is caused by the augmented changes going on in that part, or whether it arises merely from the greater quantity of warm blood which passes through it. John Hunter made some observations to determine this point, and never found that the temperature of an inflamed part was raised above that of the interior of the body, which it might be expected to be if inflammation was in itself a calorific process. That extensive inflammation raises the heat of the whole body, as well as of its own site, is quite certain; but this may be simply by causing general excitement, especially of the circulation and respiration, and by repressing the perspiration and other exhalations, by which the body is naturally cooled. Increased heat is a very important and valuable symptom of inflammation, since it is more constantly discernible than any other, and serves to distinguish inflammation from congestion and nervous irritation, which may resemble it in other symptoms. But to indicate inflammation the heat must be continued, and not merely coming in flushes with simple determination of blood. Generally the skin is dry as well as hot: but it may be perspiring, and yet a temperature, higher than natural, may be sustained.

432. The *swelling* of an inflamed part is caused in some degree by the enlargement of the vessels, but chiefly by the effusions from them, and will be therefore proportioned to the amount of these: but the situation, form, and degree of the swelling will also greatly depend on the natural structure of the part inflamed. In serous membranes, the vessels being comparatively few, ad-

* I have often in the dead-house seen mere congestive redness mistaken for inflammatory, because it was florid, from the action of the air, or from the translucence of a subjacent white structure. Frequently, too, the claret stain of arteries and intestines is mistaken for inflammatory redness: a common lens will prove it to be not so, by showing that it is not vascular.

mit of but little enlargement; and the effusions, not being retained by complexity of structure, soon overflow externally and chiefly accumulate in the most dependent parts of the serous sac, causing dullness on percussion, and sometimes fluctuation in the chest and abdomen, and when in large quantity distending these cavities. Mucous membranes are more vascular and complex in structure: hence the enlargement of vessels early causes some thickening; but the swelling is chiefly due to interstitial effusion in the submucous tissue, (so manifest in coryza and cynanche:) this effusion, when merely serous, soon passes off in the thin flux which attends catarrhal inflammations, and the swelling may subside with it: when the effusion is more solid, the swelling remains longer, is attended with a more viscid secretion, and subsides only when this secretion becomes opaque, and somewhat fat in its composition. The skin presents great variety in the swelling as well as in the redness caused by inflammation. Sometimes the swelling is diffused and hard, as in cutaneous erysipelas. In urticaria the same hard swelling occurs in spots or patches, and the effusion in parts supersedes the vascular redness, causing white centres or wheals. In tubercular inflammations of the skin the redness and swelling are still more circumscribed, and the effusion seems to be chiefly solid. In papulæ the swelling is even more minute and confined to a point. In blebs and vesicles, the effusion is between the cuticle and the true skin, and the swelling is confined to corresponding patches or small spots. Inflammation of cellular texture is attended with considerable swelling; this being diffused, œdematous, and pitting on pressure, when the effusion is serous, being more tense when there is fibrin with the serum; and being hard and subscribed (as in phlegmon) when the matter effused is chiefly fibrin. Parenchymatous organs, in like manner, are remarkably swelled by inflammation. The liver, kidneys, testicles, lymphatic and other glands, attain a large size from the mere distension of their blood-vessels; and we have noticed a similar result from mere congestion, (§ 293;) but inflammation does not last long in these structures without causing effusion, which, by various proportions of serum and lymph, may cause swelling, differing in its firmness. The lungs, from their porous structure, do not swell materially in bulk; but the effusion displaces the air in their cells, thus increasing their weight, and if the effusion abound in lymph, converting them into a more or less solid mass, like liver, (hepatization.)

433. The *pain* of inflammation is caused by that exaltation of sensibility (§ 135) which determination of blood produces, (§ 333,) often increased by the tension or pressure arising from the swelling. The amount of pain will therefore depend much on the natural sensibility of the part, the degree in which determination

of blood predominates, and the tension or pressure induced. The severest pain arises where these circumstances co-operate, as in inflammation of the pulp of a tooth, the sheath of a nerve, the lining of a bony canal, as the auditory meatus, &c. In most cases pain is chiefly felt when the inflamed part is pressed or stretched, constituting excessive tenderness. Thus the pain of peritonitis is felt on pressing the abdomen, or on straining the walls by coughing or vomiting: the stitch of pleurisy is felt on taking a full breath: the pain of external inflammation and rheumatism, on motion or pressure on the limbs. In enteritis there may be little pain until the intestines become spasmodically contracted in some parts, and distended in others, by flatus and other contents: hence the pain may vary, whilst the inflammation remains the same. Parenchymatous organs and mucous membranes being comparatively soft and yielding in texture, are not the seat of much pain, when inflamed. In the early stage, pain, with heat, may indicate the activity of inflammation, that is, the prevalence of determination of blood. In the more advanced stages, the pain rather bears relation to the amount of tension from swelling or effusion, and is commonly relieved when this becomes more diffused, or ends in suppuration.

434. Besides pain and tenderness, sensibility, increased by inflammation, sometimes exhibits other modifications, such as feelings of soreness, tingling, heat, itching, &c. Peculiar sensations are also excited in the organs of special sense when they are inflamed, such as noises in the ears, painful and disturbed vision, &c. The peculiar sensibility which excites the motions of sneezing, coughing, vomiting, micturition, and defecation, is exalted, when respectively the Schneiderian membrane, the lining of the upper part of the air-tube, the cardiac end of the stomach, the bladder, and the rectum, are inflamed. Other sympathetic sensations excited by inflammation are peculiar to disease, as the pain in the shoulder-blade, with inflammation of the liver; pain in the testicle, with inflammation of the kidney; pain of the glans penis, in inflammation of the bladder; pain of the knee, with inflammation of the hip.

435. Contractile fibre is not itself prone to inflammation; when the parts contiguous to it are inflamed, the effect is commonly first to increase its irritability, and subsequently to impair it, probably by exhaustion. Thus the heart, when its membranes are inflamed, acts first with great force and frequency, but subsequently with feebleness and irregularity. When the intestines, bladder, or air-tubes are inflamed, there is contraction followed afterwards by more or less weakness of the muscular fibres of these parts.

436. Other functions are somewhat similarly affected under

the influence of inflammation. In inflammation of the brain and its membranes, there is commonly at first, more or less excitement of the sensorial functions, causing delirium, hallucinations, and convulsions: afterwards ensue stupor and coma, and paralysis. In the early stage of inflammation of the spinal cord, there may be tetanic convulsions; afterwards follows paralysis. Often symptoms of partial excitement are conjoined with others of interruption of function; and this is not extraordinary, seeing that inflammation comprises diminished as well as increased flow of blood, and the former generally predominates as the inflammation advances and effusion proceeds. Inflammation of the lungs causes dyspnœa: that of the stomach interferes with digestion: inflammation of the kidneys suspends or impairs their secreting power, &c. It is needless to go into further details.

CONSTITUTIONAL SYMPTOMS OF INFLAMMATION.

437. The irritation of inflammation frequently extends itself to the system at large. The functions of the whole body are disordered. The contractions of the heart are more frequent and forcible than usual: the arterial tonicity is increased, (§ 121;) hence the pulse is quick and hard: the skin is dry and hot: the appetite and strength are impaired: and the natural secretions are diminished and otherwise disordered. This is *inflammatory fever*.

438. Among the most important general effects of inflammation must be noticed the change in the condition of the whole blood. We have before noticed, that there is an excess of fibrin and of the colourless globules in the blood in inflammatory diseases, (§ 195;) and that the separation and contraction of this fibrin (§ 203, 4) takes place in an unusual degree, and produce the peculiar buffed and cupped appearance of the clot so remarkable in inflamed blood, (§ 208.) This excess and separation of fibrin displayed in the buffy coat is commonly proportioned to the extent of the inflammation and its duration in an active state. This would suggest that the change in the blood is altogether produced in the blood-vessels in and near the inflamed part; and that the increased development of white globules, seen by aid of the microscope, (§ 415,) is a kind of demonstration of this production. This supposition derives support from the fact, that blood drawn directly from an inflamed part is more buffed than that drawn from a distant part.* The excess and separation of fibrin is more remarkable in inflammations of serous membranes than in those of mucous membranes, or parenchymata, which

* I have observed this even in blood drawn by cupping, on a part inflamed by the previous application of a blister.

may perhaps be ascribed to the former inflammations being attended with less local vascular distension and overflow of the exudation globules and fibrin. Acute rheumatism presents the highest degree of the buff and cupping of the blood; perhaps because the inflammatory irritation arising from matter in the blood itself* (§ 251) affects a great many vessels, yet without completely obstructing them, so that determination of blood predominates over congestion; and although there may be much inflammation and effusion of the early kind, (§ 423,) this does not lead to suppuration, or other of the more destructive changes which follow inflammation. It has been before mentioned, (§ 245,) that an increased activity of circulation and respiration might contribute to augment the fibrin of the blood in acute rheumatism and other inflammations not impairing the respiratory function; but it was then objected, that the increase of the fibrin is sometimes observed in rheumatism without much acceleration of the pulse and breath; and, on the other hand, in fevers in which the pulse and breath are much hurried, the fibrin of the blood is even diminished, (§ 196.) And it was found, by Andral and Gavarret, that in fevers, the occurrence of local inflammation always caused an increase of the fibrin in the blood.

It seems pretty clear, then, that the increase of fibrin, and its more contractile and separating quality, originate in the vessels of the inflamed part, and must be regarded as an augmentation of the vital process of nutrition developed by inflammation. A similar augmentation takes place in the vessels of the uterus during pregnancy, when the blood drawn generally exhibits a buffed appearance; and although such an appearance is not commonly presented by blood drawn from fast-growing children during health, yet in them it is very readily induced by inflammation, and the plastic products are unusually copious. It has been mentioned, (§ 415,) that in young frogs, even in health, many white globules are seen in the blood-vessels adhering to or moving slowly along their sides; and this appears to be a proof of the activity of the same nutritive or plastic process which is exalted to its highest degree in acute inflammation.

439. It has been supposed that the inflammatory or fibrinous state of the blood is the cause of the general excitement constituting the symptomatic fever accompanying inflammation; but it may be objected, that this fever frequently rises high before the blood has begun to exhibit the buffy coat, often subsides when the buffy coat is most abundant, and is sometimes wholly absent when the blood is both buffed and cupped, as in subacute rheumatism. It is very probable, however, that the excess of fibrin

* The buffed appearance of the blood in inflammatory dropsy admits of a similar interpretation, (§ 385.)

may contribute to the excitement; and it certainly materially affects the duration and the products of the inflammation.

440. In inquiring into the pathology of inflammatory fever, we must bear in mind, that it sometimes precedes the distinct development of the local inflammation, being, in fact, a general excitement or reaction after the disturbing influence of the exciting cause. This is especially the case where inflammations are produced by cold, fatigue, and other causes which first induce congestion, (§ 403.) The operation of these causes is at first depressing to the whole system; and the continuance of this marks the cold stage of the fever, with weak pulse, coldness of the extremities and surface, general pallor, various uneasy feelings, dejection of spirits, and depression of strength. Afterwards ensues the reaction, beginning with rigors, accelerated pulse and breathing, sometimes vomiting, or other functional disturbances: soon the skin becomes hot, the pulse hard, as well as frequent; uneasy feelings in the head, back, and limbs, are experienced, with thirst, loss of appetite, restlessness, and much weakness. It is during or after the establishment of this reaction that the local symptoms of inflammation may become prominent. During the cold stage, they may have been chiefly those of congestion of the affected organ, (§ 303,) impaired function, with more or less uneasiness; but now pain, (§ 433,) heat, (§ 431,) and various symptoms of local irritation, (§ 434,) ensue; and frequently, as these become developed, the general disturbance is less complete. In eruptive fevers, the general disturbance and functional disorder is greatest before the eruption (or local inflammation) appears. In inflammations from cold or fatigue, the first disorder sometimes resembles that of continued fever, which is changed for simple inflammatory fever as soon as the inflammation is pronounced. In other cases, again, chiefly those which originate from local irritation, (§ 402,) the inflammation is developed, and its symptoms are prominent, before the symptomatic fever is excited. Generally the fever is in proportion to the severity or active character of the inflammation; and if it were always so, we might conclude that the fever is the result of a reaction from the disturbance of the circulation produced by the inflammation; but we sometimes find inflammation of trifling organs, such as the tonsils, attended with a very smart fever; and much greater disturbances of the circulation, such as congestions of the lungs and liver, take place without causing any fever. It seems more probable, then, that the fever accompanying inflammation arising from local irritation, is caused by an exciting influence propagated from the inflamed part to the heart and arteries through the medium of the nerves. The same influence also sustains the inflammatory fever in the cases before noticed in this paragraph, in which the first febrile movement seems to be the result of reaction.

441. It still remains unexplained why, in fever, the circulation and some functions are excited, whilst others, as secretion, muscular strength, and the appetites, are much impaired. We cannot entirely solve the difficulty; but we may point out that the excitement is not one of a healthy kind, being attended with an excessive tonicity of the arteries, (§ 121,) which is the cause of hardness of the pulse, and which may transmit the blood through the capillaries too rapidly to permit of its proper changes by excretion. It is also possible that the vital powers of secretion (§ 158) may be more directly impaired by the inflammation or its cause; for it is certain that, either as cause or effect, imperfect secretion is one of the most prominent elements of fever in general. Thus the bowels are generally costive; the urine scanty and high coloured; the skin dry; the tongue clammy, with thirst; and ulcers or sores, that may have been discharging before, now become dried up. So, too, on the subsidence of the fever, all these secretions are restored.

443. The fever accompanying inflammation is generally *high*—that is, attended with hard pulse, hot skin, and general excitement—in the young, the sanguine, (§ 38,) and plethoric, (§ 279;) those, in short, in whom the vascular system is naturally active, (§ 401.) On the other hand, it is commonly *low*—that is, with weaker, though sharp and quick pulse, less general heat of skin, and with tongue more foul, and functions often rather oppressed or disordered than excited—in persons of phlegmatic temperament, (§ 40,) and in those weak from age, disease, mal-nutrition, intemperance, or confinement. The type or character of the fever also varies with the seat of the inflammation, and the particular textures affected, although the variation is less constant than it is generally represented to be. It is commonly stated, that the fever is high in inflammations of most serous and fibrous textures, and in phlegmonous inflammation of cellular texture; that it is low in inflammation of the stomach and intestines, kidneys, large joints, and in diffuse inflammation of the cellular texture; and that the fever is of an intermediate character in inflammation of mucous membranes and parenchymata. Clinical experience however shows that there are many exceptions to these statements; and where the type of the fever is affected by the texture, it is chiefly by the intensity of the inflammation and the nature of its product. Diffused inflammations, of little intensity, often excite very little fever, and few local symptoms. The reverse is the case of very acute inflammations even of moderate extent.

443. The exciting cause, or some co-operating influence, often materially affects the type of the fever. The inflammation occurring after serious accidents or burns is often attended with a low fever, the reaction being imperfect from the continued depressing

influence of the cause. The same remark is applicable to the case of inflammation from poisons, which are locally irritant, but sedative to the system. Even the long operation of cold may so depress the vital powers—especially that of the heart (§ 75)—that the reaction is imperfect, and the fever is low: thus, in very inclement seasons, inflammations are often attended by a typhoid or adynamic form of fever, (§ 25.)

444. In the lower forms of inflammation, (§ 442,) the fever may be remittent or even intermittent: a state of depression alternating with a state of excitement, ending with perspiration; and when inflammations become chronic, or are of slight character, they may excite no fever at all. They generally, however, induce some constitutional disorder, in which defective excretion (§ 171) is commonly a predominant element. When it is borne in mind that inflammation includes determination of blood, it will be obvious that, besides the irritation connected with it, there may be more or less exhaustion of other parts of the body, (§ 331:) the part inflamed being over-supplied with blood, other parts are in want. This effect is most obvious in anæmic and debilitated subjects; and to it must be ascribed the weak circulation, coldness, disordered functions, and gradual emaciation of the body in general, when a part long suffers from low inflammation.

NATURE AND SYMPTOMS OF THE TERMINATIONS OR RESULTS OF INFLAMMATION.

445. The results or events of inflammation may be comprehended under four heads: *Resolution*, *Effusion*, (including adhesion,) *Suppuration*, (including ulceration,) and *Gangrene*. It must not be supposed that these often occur quite singly, or that they are separated from each other by a very marked line; but these terms are conveniently attached to those results in which each respectively predominates.

Resolution consists in the cessation of the inflammation, and the speedy removal of any slight effusion. As the essential parts of inflammation appear to be determination of blood, with obstruction to its flow through some vessels; so the resolution of inflammation consists in the yielding of the obstruction and the subsidence of the determination, the vessels contracting to their normal dimensions. This may be well seen under the microscope. Sometimes nothing remains of the inflammation, but more or fewer of the white globules adhering to the sides of the vessels; but more commonly some vessels are still obstructed, and others congested, with the motion in them slower than usual, the determination of blood (enlargement of the arteries) having ceased. So commonly, we find congestion remain in a part that has been inflamed; and not unfrequently a flux or watery effusion may result from that congestion, (§ 375.)

446. Resolution of inflammation may occur spontaneously in slight cases; or in consequence of treatment; or from the inflammation being transferred to another part. Some inflammations creep to adjoining parts, as in the case of erysipelas and some serpiginous cutaneous eruptions. Others affect similar textures in different parts of the body; and being resolved in one part, appear in another: this happens in rheumatism, which affects fibrous textures, and is transferred from limb to limb, or joint to joint, by what is called metastasis, or translation. This may be fairly traced to the mobility of the peculiar *materies morbi*, (§ 402,) the cause of the inflammation. A remarkable metastasis of resolving inflammation is sometimes seen in parotitis, the breast or the testicle becoming the seat of the new attack.

447. The occurrence of resolution is marked by a subsidence of the chief symptoms of inflammation: first, of the heat and pain, and, more gradually, of the redness and swelling. The heat usually yields to perspiration. The pain becomes gradually easier: and in some parts, as the skin, may pass into itching before it subsides. The redness sometimes simply fades; more commonly it becomes less florid, and may pass through shades of a livid or dusky hue before it vanishes. The swelling soon subsides; the effused fluids being so speedily removed by absorption, that effusion can scarcely be said to have been a result. Still, in some instances, congestion, or some of its results, (§ 274, 350,) or nervous irritation, (§ 126, 152,) remains behind after the inflammation has ceased.

448. The resolution of any considerable inflammation is marked by a reduction of the fever: the pulse becoming softer and less frequent; the skin moist with perspiration, sometimes profuse; the urine, becoming more copious, abounding in urea, and depositing, as it cools, a plentiful, lateritious, or branny sediment, consisting of lithate of ammonia. The constancy of this last change on the decline of inflammatory fever has led to the supposition that it is critical, and determines the removal of the disease. The lateritious sediment in the urine is a pretty certain symptom of the subsidence of fever, and of the amelioration at least of the inflammation which excited it; but it is uncertain how far it is the cause or the effect of the improvement. It indicates an increased excretion of the solid constituents of the urine; for there is often an excess of urea as well as of the lithates; and comparing this with the scanty secretion of urine during the febrile excitement, and the decay of tissues which is always

taking place, (§ 254,) we can scarcely avoid the conclusion that these excrementitious matters had been accumulating in the blood from the impaired function of the kidneys during the fever; and that now, as the fever subsides, and their function is restored, the accumulated matter is thrown off. Now, although the function of the kidney must be first impaired to cause the accumulation of the excrementitious matter in the blood, yet this matter so retained tends to keep up the disorder, (§ 68, 171;) and it is by means which promote the elimination of this matter that we succeed best in reducing febrile excitement. So, likewise, in cases where the function of the kidneys is permanently impaired by Bright's disease, (congestive degeneration, § 309,) inflammatory and other fevers are not readily brought to a termination: persons so affected are said to be "bad subjects," with "broken-down constitutions;" and they often sink because their excreting organs are unequal to the increased task thrown on them. In cases in which the resolution of the inflammation is only partial or imperfect, a daily remission or alleviation of the fever may take place; and with it there is usually a deposit in the urine, of a pinker or lighter colour than the usual brown lateritious sediment, and containing, besides lithate of ammonia, purpurate of ammonia and lithate of soda.

Effusion (*including adhesion*).

449. Effusion we have already found to be a result of inflammation, (§ 423;) but it is not always, like resolution, a termination of this process, (§ 427.) An abundant effusion of liquor sanguinis, of coagulable lymph and serum, of pus, or of inflammatory mucus, usually lowers the inflammation—that is, reduces the determination of blood, and may diminish the obstruction, but often does not remove it; and the effused matter may cause sundry mischievous effects, by compressing, stuffing, or obstructing the several structures in which it accumulates. We may with advantage pursue the history of effusions, by tracing their changes in the chief elementary tissues.

Serous membranes, being simple in structure, give us the best illustration of the history of inflammatory effusion. In acute inflammation in a healthy subject, besides serum, an exudation of fibrin or coagulable lymph takes place in a few hours. This fibrin is at first in a semifluid, ductile state; so that the motion or pressure of the inflamed surfaces draws it into bands or threads, or spreads it into films, as we see it on the pleura, pericardium, and peritoneum. But if we examine inflamed surfaces which are less exposed to motion or pressure, as the looser parts of the auricles of the heart, the serous covering of interlobar divisions of the lungs, that of the less projecting parts of the intestines, and of the convolutions of the brain, we find the deposit of lymph not uniform in a film, but in points forming a granular surface; which shows that either more is effused at some points than at others, or that the concretion of fibrin having begun in points, chiefly augments around the same points. The granules thus deposited vary in size, from that of a grain of sand to that of a millet-seed; but if the deposit increases, they enlarge into patches, which may run into one another, often forming a mammillated coating of lymph. Even on surfaces which are subjected to motion, the prevalence of the fibrinous effusion at points is shown by a villous or shaggy appearance of the lymph, from this, in its ductile state, being drawn into threads projecting from the points where it has first concreted: this is sometimes well seen in the pericardium. In the pleura, these inequalities are more obliterated by the rubbing motion of respiration, or by the pressure of liquid effusion.

450. The lymph thus effused is (like the buffy coat of inflamed blood) at first transparent; afterwards it becomes yellowish, and more or less opaque, but in inflammation of a healthy subject generally retains some degree of translucency. In this respect, it contrasts with the product of inflammation in unhealthy subjects, purulent and tuberculous lymph, which is more opaque. But the most important character of healthy lymph is its high susceptibility of organization, which character I will in future designate by the term *euplastic*, (§ 211.) Euplastic lymph consists of fibrils of fibrin crossing each other in various ways, and mixed with numerous exudation corpuscles, both compound (cells with nuclei and granules) and simple, (granules and molecules.) Now, these are also found in the buffy coat of inflamed blood, (§ 212;) and there can, therefore, be no doubt of their identity, and that the blood thus altered by the inflammatory process is their source, (§ 438.) This leads us to anticipate what is the fact, that the plasticity of lymph will depend much on the good quality of the blood, as well as on the energy of the inflammation. Healthy blood, which abounds in red particles as well as in fibrin, furnishes the most plastic kind of lymph, (§ 183;) and inflammation, attended with the most active determination of blood, (so long as the integrity of the vessels is preserved,) separates this lymph in the greatest abundance. This lymph already possesses living properties, for its materials arrange themselves into the basis of a texture; but to sustain the life of this texture, it must be supplied with blood, and this takes place in the wonderful process of the formation of blood-vessels in it, which communicate with those of the adjoining parts.

451. The precise manner in which vessels are formed in lymph

is not distinctly ascertained. Mr. Kiernan observed inflamed capillaries become varicose, and at points project in pouches and diverticula, and stretch into loops. If these gave way, the blood would be injected into the lymph; and if something of channels were previously formed by the arrangement of the fibrils, or the elongation and communication of cells, it is quite conceivable that a current would be effected by the vis à tergo through several openings, and that a return of the blood would take place by a reversal of the weaker currents. But the actual observation of the mode in which new vessels are formed is yet wanting. It has been ascertained by Schrœder, Liston, and others, that the new vascular channels are at first much larger than the vessels which supply them; they are afterwards contracted by the formation of a basement membrane lined with epithelium; and the whole texture becomes more consistent and less bulky, exhibiting a filamentous and cellular structure, with nucleated cells scattered through it. This new membrane forms patches on, or adhesions between, the serous coverings of the lungs, the heart, and intestines; and provided these false membranes are loose, and of moderate thickness, they may cause no disorder.

452. When the inflammation is of a low character, or when the blood is poor in red particles, and especially when these two conditions are combined, the solid products of inflammation are less capable of organization, and therefore may be called *caco-plastic.* As the process of organization varies in degree, so these products may attain to different degrees of structure, forming membranes of a denser, less pliant texture, and less vascular than the serous membranes to which they are attached, and which they therefore shackle. Thus patches of a kind of fibro-cellular or fibro-cartilaginous membrane are formed on the lungs, the heart, and the intestines; sometimes with the effect of materially impeding the functions of these several organs. Where the effusion of lymph is scanty and slow, its granular mode of deposit is more obvious than in the more acute disease; for being less ductile, it is less readily spread or stretched by the motion of the parts, (§ 449.) This is well seen in chronic inflammations of the peritoneum and arachnoid, in which the deposit is almost entirely in granules or flattened patches, commonly called tubercles. These are generally of a buff or skin colour, of firm consistence, and sometimes exhibit slight traces of blood-vessels in them;* but sometimes their colour is more

* Mr. J. Dalrymple has observed, that the vascularity of lymph may be seen earlier, in cachectic and scorbutic subjects, than in healthy lymph. But syphilis and scurvy may moderate inflammation, without rendering the lymph aplastic: the great impediments to organization of lymph are, its bad quality and excessive quantity, and the persistence of inflammation. In a scorbutic subject, Mr.

yellow and opaque, their texture uniform and tough, and they are totally destitute of vascularity. These constitute the formations described under the names cirrhosis and crude yellow tubercle, and are the lowest of the organized products. Being, in organization and consistency, dissimilar to the membranes on which they are formed, they prove a source of irritation and constriction; and being liable to ulterior changes, (shrinking and contraction in the case of cirrhosis; further degeneration and softening in the case of yellow tubercle,) they may bring further mischief in contiguous parts.

453. In some cases, again, more or less of the product of inflammation is *aplastic*, or totally incapable of organization, and is thrown off with the liquid in separate large globules filled with granules and molecules, constituting pus; or in detached flakes or curds, consisting of aggregations of irregular opaque corpuscles and molecules held together by a few fragments of fibrils: such effusions are exemplified in the sero-purulent liquid and curdy matter of low pleurisy, pericarditis, and peritonitis. It is obvious that such lifeless products must act prejudicially on the containing structures; and the fact might be anticipated that they are little susceptible of absorption.

454. I have mentioned (§ 452) a low form of inflammation, and an unhealthy condition of the blood, as causing the cacoplastic character of the products of inflammation. It may be added, that the long continuance of any inflammation, and its occurrence in subjects in whose blood fibrin abounds, while the red particles are scanty, (§ 185, 195,) will pretty surely render the products cacoplastic or aplastic. At the onset of inflammation, its products may be plastic, and the process of vascular organization (§ 451) may commence; but if the inflammation continues, its product either is thrown beyond the reach of vascular communication, or displaces that already effused, and thus the outer layer will be in a degenerating condition. Added to this, the pressure of the liquid effusion may impede the construction and injection of the new membrane, which therefore is degraded into one of the cacoplastic or aplastic matters above described. Again in scrofulous or cachectic subjects, the blood, although scanty in red particles, abounds in fibrin, and this is readily effused in inflammation; but it is of low vitality, and susceptible of little or no organization.* There is yet another

D. has shown, that even a large coagulum of blood may soon become vascular; but it does not follow that either this or lymph in such subjects can be formed into real texture.

* When a coagulum of fibrin is retained long in a vessel without becoming organized, it loses its structure, and softens into an opaque semifluid matter, which long was mistaken for pus; but Mr. Gulliver has shown that it consists of

circumstance tending to lower the plasticity of lymph, although, from the observation of Mr. Dalrymple, it sometimes accelerates its organization*—that is, the admixture of the colouring matter of the blood with it. Laennec supposed that contraction of the chest had its origin in hæmorrhagic pleurisy only. This is not correct; but I have many times remarked after death, that lymph on the pleura and pericardium, in chachectic subjects, is much stained with blood; and where patients with similar symptoms have recovered from inflammation, they have been affected with structural disease. So far as we yet know, the colouring matter does not form a material for organization; and, further, it is very probable that in such cases the colouring matter is itself diseased, (§ 186.)

455. The more complex structure and secreting properties of *mucous membranes* considerably modify the form and appearance of the products of their inflammation. But, according to Gerber, Henle, and Gruby, they microscopically consist of exudation corpuscles, granules, and molecules, together with more or less amorphous and glutinous mucus, the natural secretion, and scales of epithelium. I must add, however, that, in the early stage, serum is present, manifest by the saline taste and coagulability by heat; and at an advanced stage, the mucus contains fatty matter.

Irritation of mucous membranes merely causes a flux, (§ 379;) that is, the natural mucous secretion more copious, watery, and saline than usual, and containing fewer globules. But if the irritation be continued, and inflammation follows, the secretion is at first diminished by the effusion of serum and exudation corpuscles into the interstices of the mucous and submucous texture, which causes more or less thickening or swelling. Soon, however, the effusion overflows to the surface in the form of a more or less viscid, saline-tasted liquid, containing more globules and epithelium scales;† and as the inflammation becomes more intense, the globules predominate, and the mucus becomes more scanty, but is still very viscid. On the first decline of the inflammation, the mucous and saline matter diminish, and the globules compose the chief mass of the secretion, and give it the yellowish or greenish opacity seen in "concocted" sputa; and this opaque matter is afterwards gradually replaced by the natural mucous secretion. In some cases, especially in young subjects and others

much smaller particles, mere irregular granules. In this state it bears the closest general and microscopical resemblance to mature and softened tuberculous matter. It appears to me, that certain softened tuberculous appearances, met with in the lymph of serous membranes and parenchymata, are similar in their nature.

* Medico-Chirurg. Trans., 1840, p. 212.

† Gruby; Morphology of the Pathological Fluids. Translated by Dr. Goodfellow. (Microscopical Journal, Nos. 19—23.)

in whom the inflammation penetrates to the submucous cellular texture, fibrinous matter is thrown out, forming films or shreds of lymph; but this very rarely becomes organized on mucous membranes, because their secreting apparatus and its product lie between the lymph effused and the vascular structure. 2 Hence the exudation corpuscles of inflammatory mucus are degenerating or aplastic, and constitute the opacity of viscid, mucous, muco-purulent, purulent, and shreddy fibrinous matters exuded by inflamed mucous membrane. If inflammation persists in a mucous membrane, the globules continue to abound in the effusion, commonly rendering it opaque and purulent; and the natural mucous secretion being impaired, the product is more diffluent. But inflammation rarely continues long over a great extent of surface; it is confined to patches, which yield their opaque effusion whilst other parts may be secreting natural mucus. Hence the compound appearance of the secretions in chronic inflammations of mucous membranes, (bronchitis, mucous enteritis, and cystitis.)

Sometimes interstitial effusion, which takes place at the commencement of inflammation of mucous membrane, is not entirely removed by the subsequent discharge. In such cases there may remain a permanent thickening of the mucous and submucous texture, which is the cause of the indurations and strictures which inflammation sometimes leaves in the intestines and urethra; and to a less degree in the air-passages. This, however, it must be observed, is the result of inflammation rather of the submucous cellular texture than of the mucous membrane itself.

456. Inflammation of the *skin* presents great varieties as to the amount and kind of its products. The full consideration of these would lead us into the pathology of skin diseases, a subject replete with interest and practical importance, although sadly neglected amidst the artificial distinctions of writers on cutaneous diseases; but the subject is too wide to be discussed here.

Some of the effusions in and from the skin have been glanced at under the head of the symptoms of inflammation, (§ 432.) It may now be added, that these effusions may consist of clear serum, with few exudation corpuscles and molecules, as in the liquid of blisters and blebs, and eczema, which dry into thin scabs; or of milky serum more abounding in the corpuscles, which dry into thicker scabs, as in herpes, rupia simplex, &c.; or of liquor sanguinis and purulent serum, with more numerous corpuscles, which form very thick, yellow, or brown scabs, as in rupia prominens, impetigo, and ecthyma; or the effusions may be chiefly solid, and into the substance of the dermis, as in tubercular inflammations and incipient pustules. In all cases of inflammation of the skin, there is an increased production of epidermis, which is sometimes thrown off in scales with the scabs; or in a peeling of the cuticle; or thickens, and forms a hard covering, liable to clefts and sore ulcerations, as in psoriasis, inveterate eczema, &c.

457. Inflammatory effusion into the *cellular texture* consists of serum, with more or less of the exudation corpuscles and fibrin. In diffuse erysipelas or cellulitis, the fibrin is deficient, and the corpuscles either are in moderate numbers, or else are degenerative, (purulent.) In phlegmonous inflammatian there is more fibrin, which circumscribes the effusion, and causes a harder swelling; and the pressure of this with a continuance of inflammation may lead to suppuration or sloughing.

458. Effusions from inflammation of *parenchymatous organs* resemble those from inflammation of cellular texture; but the parenchymata in general being very vascular, as well as yielding, the solid effusion may be very copious, without causing the pressure or tension that leads to suppuration and gangrene. The lymph effused exhibits, in regard to plasticity, the same varieties which we have described in the products of serous membranes, (§ 450, *et seq.*) But inasmuch as lymph effused in the parenchyma of an organ would greatly interfere with its function, we rarely find it to become organized, except in limited portions, which thus remains solid and dense. More usually the matter deposited is gradually removed by absorption or secretion after the inflammation declines, or if the inflammation continues, the exudation globules and lymph are converted into, or replaced by pus or tuberculous matter—that is, degenerated corpuscles.

459. Effusion so closely attends the process of inflammation, that the *symptoms* of effusion have been comprehended in those of inflammation. Swelling, pressure, obstruction, irritation, consolidation, displacement, and various functional, as well as structural disorders, may arise from the presence of effused matter. Hence the occurrence of effusion may aggregate some of the symptoms of inflammation, whilst others may be more or less relieved by it. Where a copious effusion takes place, the pain, heat, redness, and fever, are commonly reduced; for the vascular and nervous excitement and determination of blood are lessened; but the local or visceral disorder may be increased. The pulse may be as frequent, but it is less hard and full; the fever less constant, but it may continue in a lower degree, or assume a remittent or hectic form. The relief by effusion is greatest in slight inflammations, or where the effused matter can be thrown off from the body, as in the case of mucous membranes; but there may be much irritation and exhaustion of strength in the process of throwing it off, (as in cough and expectoration, diarrhœa, purulent micturition, &c.;) and these will be more harassing where, as

we have found is sometimes the case, the effusion does not remove the inflammation.

Suppuration and Ulceration.

460. The formation of pus among the products of inflammation has been several times noticed, (§ 424, 453, 455, 457, 458.) Pus is an opaque, greenish, or yellowish white liquid, of creamy consistence, little odour, specific gravity varying from 1030 to 1040. It is chemically composed of water, albumen or fibrin of the globules, (pyine,) albumen in solution, fat, osmazome, and the same saline matters as those in the blood. According to Gerber, mature pus contains more fat and less albumen than that recently formed.

Microscopically, pus consists of serum, and globules of pretty regular size and form. These globules are obviously a modification of the exudation corpuscles; each consists of a fluid, with granules and molecules contained within a thin cell, which sometimes has granules also on its surface. The granules render the appearance of the investing cyst or cell obscure; but its existence is clear from the action of distilled water, which causes the cell to dilate (by endosmosis) to double its former size;* and what is curious, the continued granules swell also, which shows their vesicular nature. Pus globules are larger than the general size of exudation corpuscles, (§ 424,) and exceed in size the blood discs, (Gulliver.) According to Mr. Addison, they measure from $\frac{1}{2000}$ to $\frac{1}{1500}$ of an inch. Besides in size, they differ from other exudation corpuscles in being more distinctly vesicular, and containing a fluid, as well as granules: their more readily swelling, bursting, and shedding their contents under the influence of water or solution of potass, (Addison,) may be referred to the same difference. This probably imitates the process by which the exudation corpuscle is converted into a pus globule. From a peculiar constitution either of the corpuscles or of the adjoining fluids, the disposition to endosmosis is increased, and the corpuscles, and even their contained nuclei, swell into vesicles, instead of remaining in the gelatinous condition which characterizes the corpuscles within the blood-vessels, (§ 416,) and in coagulable lymph, (§ 424.)†

* Gulliver; Notes to Gerber, Pl. 259, 60. Gerber describes pus globules as flattened discs, consisting of seven granules, without an investing cell, and formed by a partition of the exudation corpuscle into these granules. This statement is not confirmed by Gruby or Addison, whose descriptions more correspond with those of Mr. Gulliver, and with observations which my friend Mr. Dalrymple has described to me.

† Pus is not produced in birds or in cold-blooded animals; the reason of this is not understood, as the exudation corpuscles do not materially differ from those

461. Another distinguishing character of the pus globules is their want of cohesion; and in proportion as they predominate, they impair the consistence of fibrin or mucus with which they may be combined. Pus effused into cellular and complex textures also impairs their cohesion, and leads to the destruction of their substance; hence suppuration consists in not only the formation of pus, but also its substitution for more or less of the inflamed texture: for this reason suppuration, more than effusion, may be called a termination of inflammation, for the inflamed vessels are in great part destroyed.

462. The circumstances which determine suppuration as a result of inflammation, are chiefly three:—1. A certain intensity (obstruction and determination in the vessels, § 419,) and duration of the inflammation; 2. The access of air to the part; 3. A peculiar condition of the blood.

1. Intensity and continuance of inflammation pretty surely lead to suppuration in common inflammation of the true skin, cellular textures, glands, and most parenchymatous organs. Lymph is effused first, and it is pretty certain that the exudation corpuscles, at least, of this lymph, are changed into pus globules by the continued operation of the distended vessels. In circumscribed external inflammations, pressure, which reduces the distension, sometimes prevents suppuration; and in serous membranes, intensity and continuance of inflammation do not lead to suppuration, because the distended vessels are fewer and smaller, and in less close contact with the exudation corpuscles. In mucous membranes, duration, rather than mere intensity of inflammation, causes the more abundant formation of pus; but the disposition of mucous membranes to secrete pus rather than lymph may depend on the disintegrating effect of the remaining mucous secretion.

2. The access of air to a wound or to a serous membrane distinctly promotes the formation of pus, probably by a chemical influence, which disposes the exudation corpuscle to swell into a vesicle; but it is uncertain how much this influence may be due to a chemical change, and how much to the increased irritation which the contact of air may cause on living parts. Certainly a limited access of air promotes the decomposition of pus, and leads to serious consequences from its putrefactive changes.

3. The condition of the blood which promotes the suppurative termination of inflammation is not well understood. It is generally connected with a cachectic, ill-nourished state of the system, as exemplified in persons affected with impetigo and other

of mammalia. A careful investigation of the products of inflammation in birds, as well as in animals, would probably throw much light on the true nature of pus and lymph.

suppurating diseases of the surface, in whom slight scratches or punctures readily fester, and whose wounds do not heal by the first intention, (simple plastic adhesion.) It has been said that, in such cases, pus globules may be found in the blood. It is quite certain, however, that the presence of pus in the body, when that is not duly limited or thrown off, causes a tendency to the production of more; and the most plausible notion with regard to this is, that it operates somewhat in the manner of a leaven, like other morbid poisons, (§ 98.) For a similar reason, suppuration, when begun in a part, usually proceeds until pus is substituted for the inflamed textures and former products of the inflammation; and until by the process spreading, the pus finds exit on some surface.

463. The process of suppuration strongly illustrates the opposite character of the elements of inflammation before alluded to, (§ 421.) The obstruction to the passage of the blood through many vessels of an inflamed part, and the increase of this obstruction by the pressure of matter effused by those vessels that are the seat of determination, reduce the vitality of the obstructed parts to so low a degree, that they are unable to withstand the chemical solvent power of the effused fluids,* exalted as it is by high temperature. The textures are therefore gradually dissolved,† and are absorbed away, whilst the exudation globules in form of pus occupy their place, and continue to be effused by the vessels which are still the seat of determination of blood. This assumes that absorption is still active in an inflamed part; and the assumption is warranted by the fact, that the absorbing vessels, veins and lacteals, remain perfectly free: and the very occurrence of increased pulsation and flow in communicating and contiguous vessels, (§ 413,) will promote the exosmosis of fluid matter by the absorbent vessels. That the pus globules should remain unabsorbed will not appear extraordinary, when their large size is taken into account, (§ 460,) and that they are not dissolved by their proper fluid. Thus the combination of apparently opposite results, which has been considered so inexplicable,—excited and lowered action, increased secretion and increased absorption,—admits of an explanation in exact accordance with all the phenomena.

464. The amount and extent of the process of suppuration

* That the liquid of pus can chemically dissolve dead animal matter was proved by J. Hunter, who found that pieces of raw meat were dissolved in abscesses, or even in pus kept warm out of the body. The experiments of Sir C. Wintringham show that other animal fluids have a like property. Dr. Prout notices similar facts.

† The idea that the removal of textures in suppuration is owing to their death, originated with Dr. Billing. (See his "Principles of Medicine.")

varies in different cases. In some cellular and parenchymatous textures it sometimes occurs as *purulent infiltration*, not circumscribed by lymph, but leaving the texture much softened, and partially removed. This diffused kind of suppuration is to be referred either to the porous nature of the organ (as with the lungs) not admitting an effusion of lymph sufficient to limit the suppuration, or to a purulent diathesis or disposition in the blood, (§ 462.) In most cases, the process of suppuration is limited around by solid effusion, which may be either the remains of the earlier product of the inflammation, or it may be thrown out expressly for the purpose of defending the adjoining structure from the operation of the pus, which is obviously a noxious matter. A collection of pus thus circumscribed is called an *abscess;* and when mature, it represents the perfection of suppuration. The blood-vessels of the inflamed part are destroyed like other textures; but their supplying trunks are obstructed by lymph; whilst the adjoining capillaries, which remain pervious, become dilated and varicose on the walls of the abscess, which are lined with a coating of organized lymph, the vessels in which continue to secrete pus; whence this lining is called the *pyogenic* membrane. As the pus increases, the abscess becomes enlarged, generally towards some cutaneous or mucous surface where it *points;* the skin or membrane ulcerates, and the pus is discharged. The direction which the abscess takes seems to be that in which there is least resistance: the parts here are more stretched than others; and from being stretched, their vessels are more obstructed, so that they cannot maintain the vitality, nor throw out the same amount of protecting lymph, which limits the abscess in other directions. Fibrous and other hard textures resist the progress of abscesses and the escape of pus. Serous membranes, by their ready plastic process, first adhere together, and then often give passage to the contents of an abscess through them, without any pus escaping into their sac. Thus abscesses of the liver and kidney make their way across the peritoneum into the intestines, through the walls of the abdomen, and even through the diaphragm, pleura, and lungs. Where pus from an abscess does make its way into a serous sac, it causes severe irritation, and fatal inflammation.

465. After an abscess has opened, it may continue to discharge pus, pure or diluted with serum or sanies; but in healthy subjects, a process of healing takes place by an increased effusion of lymph, and growth of new vessels in it in the form of *granulations*, throughout the interior of the abscess. Pus is still formed by the superficial layer of exudation corpuscles degenerating or swelling; and a free vent must be given to this pus until the growth of the granulations and the contraction of the walls shall have obliterated

the cavity of the abscess, and left no more room for the pus to accumulate.

466. *Ulcers* sometimes arise from abscesses: an abscess that has discharged its contents is, in fact, an ulcer. But more commonly, ulcers originate from limited inflammations of the skin or mucous membranes, in which the natural cohesion of the skin is so much impaired, that it is broken up at one or more spots, and either carried away in the pus discharged, or absorbed. There is then left a solution of continuity or excavation, the bottom and edges of which continue to discharge pus, or a serous fluid mixed with exudation corpuscles, and sometimes blood particles. Ulcers may tend to spread by the same process; or to heal, by the effusion of fibrin on their walls and the extension of vessels into this lymph in the form of granulations, which are the materials of the new texture. Ulcers, besides, present a great diversity of character in the nature of their secretion, and the condition of their walls, as well as in the symptoms which they produce: these circumstances constitute the varieties of ulcers described in surgical works.

The cause of ulceration is commonly local, the inflammation interfering with the normal nutrition of a part. It is often preceded by induration from the amount of solid deposit; and the ulceration commences in the centre of the induration, because the nutrient influence of the vessels is most reduced by the pressure at that spot. But a very poor condition of the blood is often much concerned in determining this result, and seems to be sometimes sufficient to cause ulceration without any distinct previous induration, or even inflammation; the parts that suffer being either those which have become congested by posture, (as in cachectic ulcerations of the legs,) or those most remote from the nourishing influence of the blood; such as the non-vascular textures, the cornea, cellular parts of cartilages, &c. In cases of extreme anæmia, (§ 268,) where the fibrin and albumen of the blood are very defective, (§ 197,) ulcers of this description arise, and are to be counteracted by measures the very opposite to antiphlogistic. A similar result was found, by Majendie, to ensue in animals fed on sugar, starch, and other non-azotized articles of food.

467. *Softening* of textures may arise from the same change which, in a greater degree, and more circumscribed form, causes ulceration. It has already been noticed as an effect of inflammation, (§ 427:) and it may now be added, that the condition of the blood which disposes to ulceration sometimes leads to the more diffused operation of the same change in the softening of textures. Thus softening of the brain, liver, muscle, and mucous membrane, sometimes results from anæmia, or imperfect supply of blood in these parts.

468. It may be gathered from the previous description, that suppuration is a work of destruction, and therefore is, in some measure, to be contrasted with effusion of lymph, which is intended to be a process of construction or reparation. Pus is totally aplastic itself; it is formed at the expense of the plastic product of the vessels, and the liquid of pus seems to act as a solvent or septic on textures when their vitality is reduced. Although, therefore, suppuration is often useful in terminating inflammation, and in removing superfluous products and parts injured by it or its causes, yet suppuration must be viewed as a depressing and exhausting process, and its product as having a noxious character: the symptoms which accompany it will be found to correspond with this view.

469. The occurrence of suppuration is marked by a diminution of the heat, pain, and other signs of irritation and increased action in the part. The pain often becomes throbbing, as if the external pressure on some of the larger vessels had yielded, and these become expanded at each pulse. The swelling becomes softer; and if within the reach of touch, is felt to be first more yielding under the finger, and afterwards to present the fluctuation of fluid matter. The redness present in inflammation is also diminished, being wholly superseded by the pale yellow of purulent effusion in the central parts of the suppurating mass, being mottled by it in others, and retaining its deep character only in those parts of the circumference where the suppuration has not reached. In external inflammations, the redness of the skin becomes deeper before suppuration; but when this process reaches the skin, a pale spot is seen, which by its fluctuating feel indicates the approach of the abscess to the surface.

The great reason of the alleviation of the symptoms of inflammation, on the occurrence of suppuration, is the diminution of tension and hard swelling, which chiefly cause the pain and irritation, (§ 433,) and where suppuration takes place amidst unyielding parts, as under a fascia or within a bone, the tension is increased rather than lessened, and the symptoms of pain and irritation may be more severe than ever. The powerful influence of hydraulic pressure in causing the injection of a liquid into a compact texture, and the swelling of the pus globules by endosmosis after their first formation, will assist in explaining the effusion of pus under a dense periosteum or theca, and the extreme pain and irritation which it produces. The free secretion of pus from mucous membranes relieves inflammation, and removes the submucous deposit, (§ 455.)

470. The influence of suppuration on the system is manifest in the lowering of the inflammatory fever; the pulse losing its strength, but retaining its frequency; the heat subsiding or alter-

nating with chills and sweats; the general redness being succeeded by paleness, or a hectic flush; the urine depositing a pale or pinkish sediment; and the general excitement giving place to weakness and exhaustion. The amount of the change will greatly depend on the extent of the suppuration, and the importance of the organ affected; but another chief circumstance determining the effect of suppuration, and proving the noxious influence of pus on the system, is the difference between those suppurations that are diffused without a circumscribing barrier of lymph, and those that are thus limited, or are thrown off at once from the body.

In some cases of inflammation of the cellular texture, skin, and of serous membranes, pus is formed with little or no previous exudation of lymph, and produces in the system the most formidable effects. The pulse becomes very frequent and weak; the tongue brown and dry, or coated with an offensive fur, and tremulous; sweats break out profusely; the urine is scanty, high-coloured, and offensive, sometimes suppressed; diarrhœa sometimes occurs; hiccup comes on; the mind is much depressed, or excited by occasional delirium; the patient's manner and motions are agitated and restless; the breathing becomes hurried and sighing; and death ensues in from one to four days from the commencement of these symptoms. Similar results ensue in suppurative inflammation of veins; and they have been known to follow where an external abscess has suddenly subsided without opening, and in cases in which the discharge from a large suppurating wound has suddenly ceased. On opening the body after death, in a few such cases, nothing peculiar has been found, except a general fluidity of the blood, and the gravitative congestions and stains which that fluidity induces, (§ 196.) In most instances, however, there are found in some of the viscera, particularly the lungs and liver, *purulent deposits*, as they are called; collections of pus, generally confined to lobules or portions of lobes of these viscera, with more or less inflammatory injection and deposition of lymph around the collections. In these cases, there can be little doubt that pus in some way is conveyed in the circulation; and being arrested in the lungs and liver, leads to the formation of more, (§ 462,)—whether by the production of suppurative phlebitis, as supposed by Cruveilhier, Dance, and others, is doubtful,—and that the pus in the blood is the cause of the formidable symptoms and results above noticed. From the experiments of M. D'Arcet,* it is probable that the poisonous influence of purulent matter arises from chemical changes induced by air in its serosity, (§ 450;) but that obstruction to the circulation in

* "Recherches sur les Abscès Multiples," &c.; and "Brit. and For. Med. Rev. Jan. 1843."

the lungs and liver, and consequent circumscribed inflammations of these organs, result from cohesion and consolidation of the globules of pus contained in the blood.

Some difficulty presents itself as to the possibility of the globules of pus being absorbed, their large size apparently excluding them from passing through the coats of the vessels, (§ 463;) and it is more probable that, in the cases under consideration, pus is generated within as well as without the blood-vessels, just as we have found (§ 416) the exudation corpuscles to be, of which, in fact, the pus globule appears to be a modification, (§ 460.) In fact, Mr. Gulliver distinctly describes pus globules, with all their peculiarities of size and constitution, (§ 460,) as present in the blood of persons affected with severe inflammation and suppuration; and if these observations are exact, (as from the known accuracy of their author there is every reason to believe they are,) the varied symptoms occurring in different cases of suppuration may be fairly referred to the different amount to which the pus globules are produced within the vessels, and, perhaps, to putrefactive changes which they subsequently undergo.

471. The preceding observations prepare us for the fact that, besides the extreme effects above noticed, extensive local suppurations cause various symptoms of depression or low irritation. Of this kind are the rigors often experienced at the commencement or increase of suppuration. Dr. Billing plausibly ascribes this to the system sympathizing at the death of the part which is under destruction by the suppurating process; but the rigor not being always present suggests rather that the presence of a certain amount of pus in the blood might be its cause.

Again, when suppuration continues long, even if it be discharged outwardly, as in extensive wounds, or ulcerations of the skin or mucous membranes, there is a great wasting of strength and flesh, with a partial febrile irritation of a peculiar kind, called *hectic fever*. This is remittent in its symptoms, the exacerbations recurring once or twice daily, beginning with chills and depression, and followed by frequent pulse, partial heats, especially of the cheeks, hands, and feet, and ending in a profuse perspiration. As this proceeds, the body more or less rapidly wastes, and colliquative diarrhœa, vomiting, and aphthæ of the mouth, often hasten the fatal result. The febrile part of hectic is most observed in the young and irritable; but the depressing and exhausting effect of extensive suppuration is seen in all cases, in progressive emaciation and cachexia.

472. The matter of abscesses is *laudable* or healthy in proportion as it is thick and opaque, but uniformly liquid and free from smell; for although, even in this state, it is fit only to be expelled from the body and is prone to decomposition, yet the

formation of such pus is pretty sure to be attended with a protection of lymph, and it is far less noxious than ill-conditioned sanious matter, the fœtor of which indicates that decomposition has already begun.

Gangrene.

473. *Gangrene*, like the more complete forms of suppuration, may well be called a termination of inflammation; for the inflammation ends in the death of the part. In suppuration, the dying textures are softened and displaced by pus as fast as they die; in gangrene, the textures die more extensively than pus is formed, and they run into decomposition without being removed. In some cases, especially in limited gangrene, the dead portion is dissolved away at its circumference by the inflammatory exudation from the living parts, and it is thus separated or *sloughed* from them; but if the dead portion be extensive, and the power of the living parts low, the separating process will not be accomplished before decomposition ensues, which produces the changes called *gangrene* and *sphacelus*.

474. The circumstances which cause inflammation to terminate in gangrene are those which completely suspend the circulation in the part, (§ 273,) and those which greatly injure the composition of the blood or directly destroy vital properties. The circulation in a part may be destroyed by long-continued pressure, by severe contusion, laceration, or other mechanical injury, by extreme heat or cold, by strong chemical agents, by the excessive pressure of the solid matter effused in the early stage of inflammation, (as in carbuncle,) and even by an extreme amount of congestion.* The occurrence of gangrene is favoured by extreme weakness of the heart, the great moving power of the circulation; and the failure is most manifest in parts most remote from the heart, as in various structural diseases of this organ, in low fevers, and states of extreme exhaustion. It is favoured by ossification or partial obstructions of the supplying arteries, which, although adequate to maintain the ordinary nutrition of the part, cannot dilate to supply the demand increased by any injury or irritation of the part. The agents, which cause gangrene, by a directly destructive operation on the vital properties of the solids and fluids of the body, are various strong poisons, such as arsenic, sulphuretted hydrogen, the poison of the rattlesnake and other venomous animals, the poison of the plague, malignant scarlatina, small-pox, and erysipelas, hospital gangrene, glanders, &c.

* Two cases of gangrene of the lung which have occurred in my practice seemed referable to this cause.

475. An external part becoming gangrenous loses all feeling and other vital properties; its colour becomes livid, or leaden, greenish, or almost black, the cuticle rises in blisters on it, and begins to exhale an offensive odour. The rapidity of this change will depend much on the moisture and warmth derived from the adjoining living parts; in *dry gangrene*, the dead portion becoming horny and black instead of putrefying. For the converse reason, in internal parts the progress of decomposition is more rapid. The putrid matter affects the living body (like many animal poisons) as a local irritant, and a general sedative or depressing influence: and the symptoms will vary much as one or the other of these two operations predominates.

In persons of robust constitution, active vascular system, (§ 112, 120,) and good blood, (§ 195,) a dead part arouses active inflammation and effusion of lymph in the surrounding living parts, which may protect the system more or less completely from the infection of the dead matter. In such cases, although gangrene be present, the predominant symptoms may be those of inflammation and inflammatory fever. But living parts, with all their activity, cannot long withstand the pernicious influence of dead matter; so that if this matter be not soon thrown off in the form of a slough, (§ 473,) or liquefied in the inflammatory exudations poured out, the system becomes infected, and suffers from its poisoning and prostrating operation. This will happen more surely and early, where the dead part is in the interior of the body, of great extent, surrounded by vascular texture, and with its decomposition promoted by the warmth and moisture. In subjects of weak constitution, feeble vascular system, and blood defective in plastic matter, (§ 196,) the irritation of dead matter may fail to excite a protective (adhesive or plastic) inflammation, and the putrid or typhoid symptoms then show themselves earlier, and prove more speedily fatal. These symptoms are increasing feebleness and frequency of the pulse, reduction of the fever, collapse and extreme pallidity of the countenance, cold sweats, brown, dry, or clammy foul tongue, low delirium, or restlessness and agitation of manner, hiccup, fœtid diarrhœa, urine very offensive or suppressed, coma or syncope, and death. In external parts, or those which communicate with the surface, the putrid odour of the gangrenous part becomes a distinguishing physical sign; in gangrene of the lungs it is communicated to the expectoration and breath; in other cases, the whole body exhales a fœtid odour.

The supervention of gangrene sometimes terminates the pain and other severe symptoms of the preceding inflammation, and thus induces a false calm; but they are often replaced by distressing symptoms of nervous irritation, which subside only with the collapse of death.

476. In concluding this account of the results or terminations of inflammation, I must repeat what was said at the beginning, (§ 445,) that they rarely occur quite separately one from another, and in many instances they are all combined in different portions of an inflamed organ or texture. Thus resolution is always attended with some amount of effusion: lymph often has the colour, opacity, and much of the microscopic character of pus; suppuration is almost always preceded and generally accompanied by the effusion of some lymph; and often abscesses are attended with gangrene and sloughing of parts; and these combinations are further illustrated by the terms, *purulent lymph*, *flaky pus*, *sloughing ulcer*, *gangrenous abscess*, &c., which pathologists are obliged to employ to describe what they meet with.

VARIETIES OF INFLAMMATION.

Inflammation may vary in consequence of the predominance or defect of some of its elements or results, or from its combination with some of the other elements of disease previously considered. Or inflammation may derive a peculiar character from the nature of its exciting cause, which is exemplified in what are called *specific* inflammation. The following varieties demand a brief notice:—*sthenic and asthenic; acute, subacute, and chronic; congestive; phlegmonous; erysipelatous; pellicular or diphtheritic; hæmorrhagic;* and *scrofulous.* Of the specific inflammations, the *gouty* and *rheumatic, syphilitic* and *gonorrhœal*, will be merely alluded to.

477. The varieties of inflammation termed *sthenic* and *asthenic* correspond with the parallel varieties of plethora, (§ 279,) hæmorrhage, (§ 360,) and flux, (§ 393,) and are referable to a difference in the strength and irritability of the heart and arteries, (§ 110, 120, &c.) Thus *sthenic* inflammation is marked by a strong hard pulse, high fever, (§ 442,) very fibrinous blood, (§ 208, 438,) a full and active development of the chief symptoms of inflammation, (§ 429,) and a tendency generally to the more plastic products, (§ 450.) Patients affected with sthenic inflammation require and bear a greater amount of antiphlogistic treatment; and in them, if used in time, it is commonly most successful, for sthenic inflammation occurs in those of the most robust constitution, in whom the effects of disease are most readily shaken off.

Asthenic inflammation occurs in persons the tone and real strength of whose vascular system is low, (§ 116, 123,) and their blood (generally speaking) poor, (§ 207.) The pulse is not always affected; when it is affected, it is in frequency more than in strength or firmness; the fever, if there be any, is of a slight, remittent, or low character, (§ 442, &c.) The products are either scanty, or of a cacoplastic or aplastic character, (§ 451;) or the effusion may be chiefly watery, the inflammation differing little from flux and dropsy.

478. The terms *acute*, *subacute*, and *chronic*, applied to inflammation, properly relate to its duration; but they are often used in the sense which I have given to sthenic and asthenic. *Acute* inflammation may be, and commonly is, sthenic; but it is by no means always so: its distinctive character is, that it tends to a speedy termination of some kind or other. It may end in resolution, effusion, suppuration, or gangrene, in a period varying from a few days to three weeks. An inflammation lasting above the latter period is *subacute*, and if protracted beyond six weeks is properly called *chronic*. Very commonly, inflammation is acute because it is severe or sthenic, its intensity leading to a speedy result: but asthenic inflammation is often also short in its duration; whilst chronic inflammation sometimes presents a good deal of the sthenic character, (§ 477.) Acute inflammation, when at all extensive, is attended with considerable fever and constitutional disorder. With subacute inflammation the fever is less, and may even be absent. In chronic inflammation there is rarely fever; when present, it is of a remittent or hectic kind, (§ 444, 471.)

The products of acute inflammation are commonly so copious as to be obvious in their character, being coagulable lymph, pus, inflammatory mucus, &c. In subacute inflammation they are often intermediate, such as purulent lymph, curdy matter, and tubercle in some of its forms. As with asthenic inflammation, the more they are in quantity the less likely are they to become organized.

479. Chronic inflammation may originate in the acute or subacute forms, the vascular obstruction and excitement persisting in the part, even after some of the results (§ 445, formerly called terminations) of inflammation have been produced. Its general character is asthenic; but there may be considerable determination of blood and local excitement. Its effect in disturbing the functions, both of the part which is its seat, and of other parts, is much less prominent than that of acute inflammation; but its duration causes a more serious and lasting alteration of structure. The matter effused by serous membranes in chronic inflammation is always either cacoplastic or aplastic; hence, dense and contractile adhesions, or patches of fibrocellular or semicartilaginous matter, cirrhosis, gray miliary tubercle, curdy and yellow tuberculous matter, may be numbered among the common products of chronic inflammation. Mucous membranes discharge muco-purulent matter, and the more complex membranes of this class become thickened and may ulcerate. Sub-mucous textures become the

seat of deposit, which, in becoming organized, often contracts, forming strictures in mucous passages. These strictures, by obstructing the passages, may lead to dilatations above them. In glands and other complex textures chronic inflammation causes consolidation and induration, which often afterwards contracts and causes obliteration of the connected texture, as in the changes in the lungs, liver, and kidney, inaptly described under the name cirrhosis.* Sometimes the indurated parts, from the pressure on their vessels, become softened, (§ 463,) as in softening of the brain, or undergo a process of irregular suppuration and ulceration, as in the excavation of the lungs after chronic inflammation. As we noticed of congestion, (§ 311,) so it may be added of chronic inflammation, that the hypertrophy or excessive deposit of nutritive material is irregular, more in some textures than in others, generally abounding most in the interstitial cellular or filamentous tissue, which, by its hypertrophy, presses on the vessels and other textures, and often causes their atrophy and partial obliteration. Chronic inflammation in the cartilages ends in caries and ossification: in the bones also it causes caries or exostosis, just as in the skin and other compound textures it leads to induration as well as ulceration. The production of these apparently opposite results by the same process, inflammation, is not paradoxical, when we bear in mind the compound character of this process, and the variations arising from different proportions of its elements and products. Chronic inflammation exhibits these opposite results the more strikingly, because its effects are accumulated by its long duration; the hypertrophy arising from one of its elements (determination of blood) increases in the immediate neighbourhood of atrophy and ulceration, the results of another of its elements, (vascular obstruction.)

480. *Congestive* inflammation is that in which the accumulation and retardation of the blood in the vessels of the affected part predominate over the determination of blood. Hence it is commonly asthenic in its character, (§ 477,) and generally originates from causes producing congestion in the first instance, (§ 403,) the reaction which converts this into inflammation being imperfect or partial. Its symptoms are less prominent than those of more active inflammation, and partake more of the character of those of congestion. Thus there may be little pain, heat, fever,

* Mr. Gulliver describes the consolidation of chronic pneumonia as characterized by "dark exudation corpuscles," as pale exudation corpuscles are the chief objects in red or acute hepatization. It appears, however, that these corpuscles are not dark from colour, but merely from opacity, as pus and tubercle are; and they bear a further resemblance to this last product in their irregularity, in shape, size, and composition, being of various shapes, and consisting of molecules, generally without a nucleus, and often without envelop.—Notes to Dr. Boyd's "Vital Statistics," Edin. Med. and Sur. Jour. July, 1843.

and other signs of irritation or increased action; but the redness (where visible) is more marked and deeper than usual, and if the organ be very vascular, (as the liver, lungs, and kidneys,) the swelling may be considerable. Congestive inflammation is usually subacute or chronic, not tending to speedy results; but a kind of flux or dropsy may occur early, as from congestion. (§ 375.) So, too, the solid or nutritive effusion is generally cacoplastic, like that of congestion, (§ 311;) hence the consolidations or indurations arising from it are often of a dense or indolent kind, tending to contract, or to degenerate still further into aplastic matter, (tubercle.) The inflammation of the lung supervening on disease of the heart, on bronchitis, and asphyxia, is generally congestive; and so is inflammation of the liver from any cause.

481. *Phlegmonous* inflammation is exemplified in the phlegmon, furuncle, or boil of the integuments. Its chief character consists in its being abruptly circumscribed by an effusion of solid lymph, which brings the inflammation to a termination, either by suppuration, or by slow subsidence, as in the case of blind boils. A highly fibrinous condition of the blood (§ 195) contributes to render inflammation phlegmonous; but this form of inflammation is that commonly exhibited by cellular and parenchymatous textures. The type of phlegmonous inflammation is usually sthenic, (§ 477;) and even where it advances to suppuration or sloughing, it defends the body against the noxious influence of the pus and dead matter. Hence the fever is more inflammatory, (§ 442,) and the local pain, irritation ,and heat, are considerable.

482. *Erythematic* or *erysipelatous* inflammation is contrasted with phlegmonous, in its tendency to spread, not being attended with the effusion of much lymph. In its severe forms, it is accompanied by much redness, pain or smarting, heat, and swelling; the effusion is chiefly serous, and often raises the cuticle in blisters. In its worst kinds, it terminates in diffused suppuration, sloughing, or gangrene. The fever is also of a lower type (§ 443) than in phlegmonous inflammation; being attended by great weakness, disorder of the secretions, foulness or dryness of the tongue, with delirium, and confusion or dullness of the senses; and in the worst cases, the fever is typhoid, with stupor, muttering delirium, dry brown tongue, sordes on the teeth and lips, slight convulsive startings of the limbs, (subsultus tendinum,) fœtid or suppressed secretions, and sinking.

These adynamic or typhoid symptoms show the presence of something more than a form of inflammation, and that something must be considered to be a poison. It is probable that this poison sometimes originates in infection, (§ 93;) for persons in the same room, or who have had much communication with a patient with erysipelas, have been more frequently attacked than others; but it is also pretty certain that bad ventilation, and a crowded uncleansed state of surgical patients, are capable at any time of rendering common inflammation erysipelatous; and this effect is much promoted by unknown epidemic conditions of the atmosphere, (§ 89.) The most probable hypothesis which we can form of this matter is, that under certain circumstances the products of inflammation become (as we know they sometimes do, § 470,) poisonous; and capable of acting (as many animal poisons do) as local irritants and general sedatives or depriments; that they then modify the character of the inflammation, and depress the whole vital powers, (as we have found pus and gangrenous matter do, § 471, 475;) and that their effects, and the general and local reaction against them, (§ 17,) lead to the various degrees and forms which we find erysipelatous inflammation and its accompanying fever present. The same morbid matter, being transferred by any of the three modes of infection (§ 94) to other persons, may induce erysipelas in previously existing inflammation, or if strong enough, may develop it anew in the body. The fact that patients often *sicken* with fever (rigors, vomiting, headache, quick pulse, delirium, &c.) before the erysipelatous inflammation appears, is a sufficient proof that the poison acts on the constitution as well as on a part; and the fact that weakly persons, and those with previous structural disease, (especially of the kidneys,) chiefly suffer from the worst effects of erysipelas, shows the essentially depressing operation of the poison.

Some asthenic inflammations of mucous and serous membranes and internal organs exhibit many of the constitutional effects of the worst forms of erysipelas; they sometimes prevail when it is epidemic, and may be traced to the same infection. This may be said especially of puerperal metritis and peritonitis, erysipelatous, tonsillitis and laryngitis and suppurative phlebitis.

483. *Pellicular* or *diphtheritic* inflammation of mucous membranes has some affinity to the erysipelatous, being diffused and spreading, generally asthenic, and accompanied with a low kind of fever. It is attended with more soreness than pain, little swelling, and a deep redness, which is early obscured by the characteristic film of grayish or dirty white albuminous matter, which is exuded on the inflamed surface. Patches of this kind often occur on the tonsils in sore throat, and have been commonly mistaken for sloughs. In certain epidemics, often connected with scarlatina, a diphtheritic inflammation affects the whole throat, and sometimes extends to the trachea and air-tubes, the mouth, the gullet, and more or less of the alimentary canal. The films of lymph thus effused are often fœtid, apparently from incipient

decomposition, which is promoted by their exposure to air and moisture in the throat and air-passages. As in the case of diffused suppuration and gangrene, this result of inflammation thus tending to putrefy is at once a sign of the low condition of the vital powers, and a cause of their further depression.

The exudation of lymph instead of mere mucus or purulent mucus as usual, I am disposed to refer to the inflammation affecting the submucous cellular tissue, and being at the same time diffused like erysipelatous inflammation. Deep-seated inflammation of a more sthenic character is circumscribed by the effusion causing a thickening of the membrane, as in laryngitis; but the matter effused by diphtheritis, although fibrinous, is thin enough to transude through the mucous membrane on the surface of which it concretes. The thinness of the mucous membrane of the air-passages in children facilitates the transudation in their deep-seated inflammations: hence, at an early age, all such inflammations may cause an effusion of fibrinous matter, as we find exemplified in croup. So, too, the extreme tenuity of the mucous lining of the smaller divisions of the air-tubes makes the exudation of fibrinous matter a common result in pneumonia and some kinds of capillary bronchitis. This is exemplified in the ramiform moulds of the bronchial tubes sometimes expectorated. Similar skinlike exudations are sometimes passed from the intestines after the irritation of calomel or other strong purgative, and in some cases without any such irritation. I have at present three patients under my care, who from time to time pass from the bowels a quantity of shreds like white kid leather, without any symptoms of active inflammation: congestion seems to be a chief cause in these cases, (§ 308.)

In the mouth and throat, various asthenic inflammations seem to be capable of causing a fibrinous exudation, as that from mercurial action, and that in the aphthous mouth and throat of adults, which occurs towards the fatal termination of various chronic diseases. The aphthæ of children are different, being vesicular elevations of the epithelium, with or without a fibrinous film underneath.

484. *Hæmorrhagic* inflammation is entitled to be considered as a distinct variety. In most inflammations there are slight extravasations of blood; but sometimes there is so much colouring matter in the inflamed texture and in the products effused, that it may be difficult at first to say from the appearance whether the disease is a hæmorrhage or an inflammation. These inflammations I have found to be asthenic; often the subjects were scorbutic, or affected with purpura; and, as I have stated with regard to the latter disease, (§ 358,) there has been distinct evidence of imperfect action of the liver and kidneys. Thus I have met with

hæmorrhagic pleurisy and pericarditis in conjunction with cirrhosis of the liver and Bright's disease of the kidney. An altered condition of the colouring matter (§ 186) is perhaps more concerned in causing this result than a deficiency of the fibrin, to which it is commonly ascribed.

485. *Scrofulous* inflammation is decidedly asthenic, and exhibits many deviations from the common form of inflammation. It may be well exemplified in the lymphatic glands, one of its most common seats, and within the reach of direct observation. These glands, in common inflammation, become very painful and hot, as well as swollen, and the inflammation tends soon either to resolution or to suppuration. In scrofulous inflammation, on the other hand, lymphatic glands swell to a great size; and often the deep redness extends to the surface, but with little pain or heat; and the swelling remains for a very long period without either resolution or suppuration, and little influenced by antiphlogistic remedies. Sometimes it seems to suppurate, so that the swelling becomes distinctly fluctuating, very red, and ready to open; but afterwards the skin becomes wrinkled, and the swelling subsides. When it does burst, or is opened, the pus is serous and curdy, or mixed with matter of a soft cheesy consistence, (soft tuberculous matter;) and the abscess thus opened leaves a deep ulcer with a narrow orifice, (fistula,) which is indisposed to heal. The kind of inflammation of which this is one example, occurs in persons of what is called the *scrofulous diathesis* or *constitution*.

The scrofulous diathesis is merely a term employed to designate a state of the body in which scrofulous inflammation and malnutrition are apt to occur. It has been generally stated that this diathesis has certain outward marks, by which its existence may be recognized independently of the actual occurrence of disease. Thus a relaxed state of the muscles, a soft transparent skin, a fair or pale complexion, with partial patches of a peculiar pink or purplish redness; a pearly whiteness of the eye and teeth; tumid upper lip; fair or reddish hair; large and weak joints; precocity of intellect, and some other signs, have been described as characteristic of the scrofulous diathesis. But such marks are met with without any manifestation of scrofulous disease; and still more frequently, scrofulous disease is induced in persons quite destitute of these characters.

More constant concomitants of the scrofulous disposition (although they sometimes occur without scrofula) are, various signs of weak circulation and imperfect nutrition, such as cold extremities; weak, but easily accelerated pulse; small development of muscles; uncertain digestion and irregular excretion; slow or defective healing of wounds. The circumstances which most favour the production of the scrofulous diathesis are also causes of a weakening kind, especially when these are long continued, such as poor or insufficient nourishment, especially in childhood or youth; cold and damp situations, or defective clothing; long confinement in close, ill-ventilated habitations; long-continued illness, especially from eruptive or typhoid fevers; and prolonged and aggravated disorders of the digestive organs. Scrofula is also, in a marked degree, an hereditary affection, (§ 36;) and mere feebleness of constitution in parents, whether original or from disease, or from excesses, or from age, often develops a disposition to scrofula in children.

In persons of the diathesis now noticed, inflammation frequenlty runs a course, and leads to results different from those of inflammation in a healthy subject. Commonly the inflammation is more asthenic, (§ 477;) often it is more subacute or chronic (§ 479) than usual; but in all cases, its solid products are not euplastic, (§ 450,) as in healthy persons; and may be either cacoplastic (§ 452) or aplastic, (§ 453,) according to the prevalence of the scrofulous constitution, the texture affected, and the quantity of the inflammatory product thrown out. Where the scrofulous diathesis is most developed—where the texture inflamed is an internal one, not freely discharging externally—and where the product of inflammation is most copious,—there the deposit will be most aplastic, consisting of scrofulous pus or yellow tubercle, devoid of regular structure, and wholly insusceptible of organization; and being not fit for absorption, it operates as a foreign body, irritating, obstructing, and compressing the adjoining parts, in various ways detrimental to their functions and structure. Thus arise tuberculous or scrofulous deposits and abscesses in lymphatic glands, in bones, cartilages, and in the connected cellular textures, tuberculous infiltrations in the lungs, and deposits in serous cavities. Where the scrofulous diathesis is less pronounced, and the inflammatory effusion less copious and more gradual, the result may be a cacoplastic product, susceptible of only a low organization; as gray, miliary, and tough yellow tubercle; cirrhosis, atheroma of arteries, fibro-cartilage, and other degraded living solids. These have been already noticed, (§ 453, 454,) and will again come under consideration as products of altered nutrition. The aplastic tendency of inflammation in scrofulous subjects is sometimes manifest in other ways in different textures. Synovial membranes of joints are softened into a brownish pulp, (Brodie;) articular cartilages and the cornea ulcerate, from absorption predominating over effusion, (§ 466;) the integuments of the face and other parts inflame in small cutaneous tumours or tubercles, which ulcerate, and the ulcers are phagedenic, spreading and destroying the nose or adjacent parts, as in lupus.

It seems, then, that the most constant peculiarity of scrofulous inflammation is, that it degrades or arrests nutrition by supplying a material in a condition little or not at all susceptible of organization. This leads us to inquire what is the condition of the blood in scrofula; and we are answered by the interesting result obtained by Andral and Gavarret before mentioned, (§ 454,) that there is an excess of fibrin, (§ 195,) but a deficiency of red particles, (§ 185.) The fibrin is, however, defective in vitality; and this seems to favour the hypothesis that the red particles are concerned in preparing this plasma, (§ 210;) where they are deficient, it is ill prepared.

486. *Gouty* and *rheumatic* inflammations have already been noticed in relation to their specific cause, a morbid matter in the blood or in the textures, (§ 251, 254;) and some of the peculiar characters of the inflammation were then adverted to, (§ 385.) It is highly probable that the peculiarities of many other inflammations, especially of the skin, may be referred to a similar cause, a particular matter in the blood irritating the parts through which it circulates, (§ 402.)

487. The poisons of *gonorrhœa* and *syphilis* excite inflammations still more peculiar in their phenomena and course. *Gonorrhœal* inflammation chiefly affects the genito-urinary passages and the conjunctiva. It is generally acute, and results in the secretion of an opaque sulphur-coloured pus, which is capable of propagating the disease. Sometimes it affects the testicle also with acute inflammation, and the joints with more chronic, constituting gonorrhœal rheumatism.

Syphilitic inflammation exhibits great varieties in site and effects. Locally, the syphilitic poison may excite on any thin-skinned surface a papula, or small tubercle, which, ulcerating, forms a chancre. As the matter is absorbed from this, it causes inflammation with great pain and swelling of the neighbouring lymphatic glands, (bubo,) which may suppurate. These are primary inflammations, and of an acute character. When absorbed into the system, it may excite secondary inflammations; sore throat, generally asthenic, and tending to ulcerate; and a great variety of inflammations of the skin, which vary greatly in their type as well as in their character, according to the vigour, &c. of the subject. They often leave a peculiar lurid or copper-coloured stain in the under layer of the epidermis, which obviously arises from an extravasation of some colouring matter of the blood, and probably implies a change in it. The periosteum and bones are also often attacked with syphilitic inflammation; and painful nodes, exostoses, suppuration, and caries, may result. The iris is sometimes attacked with acute inflammation and effusion of lymph, which may endanger sight if not reduced.

TREATMENT OF INFLAMMATION.

488. We have found inflammation to be an essentially complicated process, composed of several constant elements, to which are frequently added others, which further increase the complexity of the disease. A proper knowledge of these elements, and of the means which best remove or counteract them, separately and in combination, forms the best guide to the rational treatment of inflammation, and supplies a safe clue through the confused and paradoxical assemblage of agents which experience has proved to be antiphlogistic remedies. As we have not time to discuss in detail the elements and results of inflammation with regard to treatment, it will be very useful to enumerate these elements and results, with references to the text, which more fully explains them, and then to represent in a tabular view the remedies that may be opposed to these elements and results, various combinations of which remedies constitute the antiphlogistic treatment.

489. *Constituents of Inflammation.*

From operation of exciting cause.	Congestion, (§ 403, 407,) or Nervous and vascular irritation, (§ 402, 408.)
Essential elements of inflammation, (Local.)	Determination of blood towards the affected part, (§ 409, 419.) Obstruction of the vessels most affected, (§ 410, 419;) by atonic enlargement of the capillaries, (§ 414;) by production and adhesion of white corpuscles in the vessels, (§ 415.) Distension of arteries and capillaries BEFORE the obstruction, (§ 420,) causing increased effusion (§ 423) of serum, lymph, pus, &c. (§ 427.) Emptiness of veins BEYOND the obstruction, (§ 427,) causing increased absorption, (§ 467,) hence softening, &c. Impeded or arrested circulation AT the obstruction, (§ 418,) causing a reduction or abolition of vital properties, (§ 273,) hence the death of the part, and its removal by ulceration (§ 466) and suppuration, (§ 427,) or its decomposition by gangrene, (§ 473.) Increased circulation of blood AROUND the obstruction, (§ 410,) causing exaltation of vital properties, (§ 421, 333;) hence spasm, (§ 113,) pain, (§ 135,) sympathetic irritations, (§ 149,) increased secretion, (§ 159,) &c.
Constitutional effects of inflammation, (not essential.)	Extension of the excitement to the heart and arteries, (§ 440,) causing inflammatory fever. Change in the whole blood, by increase of fibrin from the inflamed part, (§ 438,) and by diminution of the excretions by the inflammatory fever, (§ 441.) Exhaustion ensuing after the excessive excitement (§ 116) or the effusions of inflammation, (§ 459, 470.) Depression, sometimes with partial irritation, from the presence of pus or gangrenous matter in the blood, (§ 470, 475.)

490. TABULAR VIEW OF THE CHIEF ELEMENTS OF INFLAMMATORY DISEASE, AND OTHER REMEDIES.

CONSTITUENTS OF INFLAMMATION.	ANTIPHLOGISTIC REMEDIES.	
1. Congestion	Astringents; stimulants; evacuants; (§ 315, *et seq.*)	For incipient inflammation.
2. Irritation of nerves . . .	Narcotics; counter-irritants; (§ 137,155.)	
3. — of vessels	Sedatives; derivatives; evacuants; (§ 342, *et seq.*)	
4. Determination to the part . .	Cold and other sedatives; derivatives; evacuants	For local inflammation.
5. Obstruction in the part: — by atonic enlargement	Remedies for congestion, (see above)	
6. — by adhesion of corpuscles	Remedies not known; attenuants? (§ 217)	
7. Distension of vessels . . .	Counter-pressure; blood-letting; derivation; (§ 319)	
8. Effusions	Evacuants; derivatives; operations; sorbefacients?	
9. Increased absorption . . .	Direct remedies not known; stimulants; diminishing atmospheric pressure on the part?	
10. Impeded circulation in the part	Moist heat and other stimulants . .	
11. Increased circulation around	Remedies for determination, (see above)	
12. Excitement of the heart . .	General blood-letting and other evacuants; sedatives; (§ 115) . . .	For inflammation with fever.
13. — of the arteries generally	General blood-letting and other evacuants; relaxants, (antimony, &c., § 122;) salines?	
14. Change of the blood: — by increase of fibrin .	Blood-letting and other evacuants; (§ 214;) mercury; low diet . . .	
15. — by diminution of the excretions	Evacuants; alteratives; (§ 172, *et seq.*)	
16. Exhaustion	Stimulants and tonics, (§ 119, 124.)	
17. Depression from poison . .	Stimulants; antiseptics; evacuants; (§ 260.)	
18. Solid products of inflammation	Attenuants? alteratives? sorbefacients? stimulants; pressure, and friction.	

491. My limits will not enable me to do more than offer some brief comments on the principles of the treatment, and to exemplify the above table by the results of experience.

1. *Congestion.* The efficacy of topical astringents and stimulants in the congestion preceding inflammation, is illustrated in the effect of a strong solution of nitrate of silver or sulphate of zinc in curing conjunctival ophthalmia, and of the same agents, or powdered alum, (Velpeau,) or capsicum gargles, in curing an incipient sore throat. But as with regard to congestion, (§ 317,) so still more in the congestive stage of inflammation, if it be ex-

tensive, long established, or already complicated with determination of blood, stimulants and astringents do no good, and may aggravate the inflammation; and it is especially under these circumstances that evacuants, derivatives, and even blood-letting, may be requisite. The utility of these has been mentioned under the head of congestion, (§ 318;) but they may be more necessary in the congestive stage of inflammation, inasmuch as it tends to further and worse results. A strong purgative and diaphoretic, if given early enough, may suffice to remove an incipient inflammation; but if this inflammation be extensive, especially when the subject is plethoric, the proper remedy, even at this stage, is blood-letting, local or general, according to the situation and extent of the inflammation.

492.—2 and 3. *Irritation of nerves and vessels.* The irritation of the nerves, which we have found to constitute a part of the commencement of some inflammations, (§ 402,) is so closely followed by irritation of the vessels that their remedies are much the same. The efficacy of a large dose of opium in incipient inflammation exemplifies the utility of narcotics in subduing nervous irritation, and these remedies are the more indicated where pain, and other signs of excited nervous function (§ 151) predominate. On the other hand, where heat and redness rather prevail, the vessels are more excited, and the more appropriate remedies are sedatives, such as cold and saturnine lotions to the part, and various evacuants and derivatives, which draw the blood away from the excited vessels. Counter-irritants or revulsives of the most speedy operation, such as heat, dry and moist, mustard poultices, and other stimulating applications near the affected part, seem to act both on the nerves and vessels, and are powerful means of subduing the irritation which leads to inflammation. In these applications the effect on nervous irritation is proportioned to the sensation which they produce, and where pain or other signs of nervous excitement predominates, a heat almost scalding or burning, or stimulating agents which cause severe smarting, are most effectual. On the other hand, where the vessels are excited, as evinced by heat and redness, (if visible,) counter-irritants or revulsives which act extensively rather than intensely are of more avail; such as a general or partial hot bath, or large poultice, or fomentation, made more stimulant by various additions. On the same principle purgatives and other evacuants continue to be indicated. Emollient and demulcent remedies, where they can be directly applied, often soothe an inflamed surface, both by promoting the natural secretion, by removing irritating matter which may have caused the inflammation, and by reducing the acrimony of the morbid discharge, which is often acrid, (§ 455.)

493.—4. *Determination to the part.* This, with the following element, *obstruction in the part*, is only the further result of irritation of the vessels; but it is here named as a constituent of established inflammation. It is to be opposed by the same remedies as those just mentioned for vascular irritation, and formerly noticed as suitable for simple determination of blood, (§ 342, *et seq.*,) but as part of a disease which is more enduring and serious, the determination attending inflammation requires a fuller than usual application of these remedies. Of the sedatives applicable to this element, none is so effectual as cold, which we have found more than any other agent to promote the contraction of arteries, (§ 120.) It is thus that ice and cold lotions are very salutary in reducing active inflammation where they can be properly applied, as in external inflammations; in some internal inflammations the cold may be made to reach the interior, as by a bladder of ice to the head in meningitis, and by swallowing slowly small pieces of ice in gastritis. Cold will do harm instead of good in inflammation, either when it does not reach the enlarged arteries through which the determination takes place, (§ 326,) or when it is not sustained long enough to prevent the effects of reaction, (§ 79,) by which the arteries again become enlarged and determination is renewed. For these reasons, external cold applications are injurious in most internal inflammations, and if not steadily regulated, they may prove so in other cases likewise.

Warmth and other derivants applied to parts more or less remote from the vessels which are the channels of determination are very serviceable aids in the treatment of this element: thus, partial or general warm baths, hot poultices, &c., operate. Diaphoretics which equalize the circulation without stimulating, such as antimony, are also beneficial, by relaxing the cutaneous vessels generally, and thus deriving to the whole surface. So we have found (§ 345) purgatives and diuretics to operate as derivatives as well as evacuants; and blood-letting was then stated to be the most effectual of all, (§ 346.) Change of posture by elevating the part inflamed, should also be mentioned among the means which counteract determination of blood.

These different measures, which may suffice in simple determination, may be insufficient for that attending inflammation, chiefly because they cannot easily be sustained for a length of time. To produce a more permanent derivation or revulsion, as well as to act as counter-irritants, various agents are used to excite artificial inflammations, which counteract inflammatory disease by deriving and irritating in another direction. To this class belong blisters, mustard poultices, applications of tartar emetic, croton oil, strong ammonia, mineral acids, some essential oils, heat above 120° Fahrenheit, &c., varying in the amount of inflammation which they excite according to the manner and duration of their application. As these fulfil several indications in inflammation they will again come under our notice.

494.—5 and 6. *Obstruction in the part by atonic enlargement of the capillaries and by adhesion of the white corpuscles.* These two are classed together, because they both contribute to produce the partial obstruction which is characteristic of inflammation. The atonic enlargement of the capillaries may be thought to be included in the congestion before noticed; but it stands here as a part of established inflammation, and therein different from mere congestion, (§ 287.) The remedies to be opposed to it are, however, the same as those mentioned under that head; but here they generally occupy a subordinate place, unless they fulfil other indications. There are, however, a few cases in which the treatment for congestion, even by stimulants, proves effectual in curing inflammation. Catarrhal inflammations of mucous membranes are sometimes removed by a highly stimulant treatment with wine, spirits, or ammonia. It is probable that the circulation is so much accelerated as to excite the dilated vessels to contract, and the obstruction is thus swept away. This treatment generally causes sweating and a deposit in the urine; but these seem to be as much the effects as the causes of the improvement, for sweating by other means is not so effectual. But this mode of treatment is hazardous, for it acts by increasing the flow of blood, and if this fail to remove the obstruction, it will surely aggravate the inflammation.

But the most constant and important part of the obstruction of inflammation is due to the unusual formation and adhesion of the white corpuscles in the inflamed vessels; and inasmuch as it is this especially that establishes inflammation and is the cause of its most serious results, it would be most desirable to find some remedial influence to counteract it. Unfortunately, however, we are not acquainted with any direct means of preventing the formation and cohesion of these globules, or of dissolving them when formed. As these globules appear to be formed in the blood-liquor, we should look for the desired remedies among the medicines which affect the blood; and it might be surmised that alkaline and other salts may possess this virtue. The efficacy of carbonate of potash as an antiphlogistic remedy has been much vaunted by Sarconi and other Italian writers; but this is not confirmed by general experience. In fact, it appears, from the experiments of Mr. Blake, (§ 214,) that salts of potass injected into the veins promote the coagulation and stagnation of the blood instead of preventing them. Whether antimony or mercury possesses any such quality is not known; the subject deserves careful experimental investigation; for if a medicine could be found capable of fulfilling this intention, it would be the most efficacious of all antiphlogistic remedies. It cannot be doubted that blood-letting and other evacuants which reduce the mass of blood also diminish the white corpuscles as well as the fibrin, (§ 214;) but they do so at a great expenditure of the red particles, and therefore of vital power, (§ 183.)

495.—7. *Distension of vessels.* This is another of the more characteristic constituents of inflammation, and has been explained to be the result of determination of blood into congested and obstructed vessels. In congestion, we formerly found distension sometimes to occur, (§ 306;) but there it is chiefly in the veins; here it is in the small arteries, and all those parts of the capillaries that are on the arterial side of the obstruction. This may account for the greater degree of distension, and the larger amount of effusion and other changes that result from it. We see, too, that the most effectual means of relieving it will be by lessening either the determination of blood or the obstruction. The measures for reducing the determination must be now of the stronger kind, such as blood-letting and free derivation or evacuation; because the arteries which are the seat of determination are closed at most of their capillary ends, and must be drawn upon either directly or through means which reduce the pressure in the arteries generally. Where, therefore, there is any considerable determination of blood, the distension which it causes will not be relieved without drawing blood either from the enlarged vessels themselves, or from other parts, in sufficient quantity to reduce the general arterial pressure.

Other slighter means give some relief to the distension of the vessels in inflammation. External pressure, carefully equalized, can sometimes do this, as in the effect of well-applied bandages and strapping on wounds. Fluid pressure, as proposed by Dr. Arnott, by means of quicksilver, or the slack air-cushion under a bandage, might be still more useful in various external inflammations, because its equality insures its proper application. It is very probable that a part of the efficacy of poultices depends on the soft and uniform pressure which they produce on the inflamed vessels. But certainly poultices, fomentations, and other means of applying moist heat, relieve distension in the part also by relaxing the solid fibres, and by promoting the exudation of the watery parts of the blood.

496.—8. *The effusions from the vessels* are the result of their continued distension. They may therefore be prevented or lessened by means which reduce this distension; but in severe cases of inflammation, effusion is the natural mode in which the vessels are relieved of their load; and we have just mentioned that poultices and fomentations give relief by promoting this result.

If the effusion is outwardly, as from a mucous membrane, it may not be necessary to check it, except so far as it may interfere with the functions of the part; but if it be too thick, alkaline medicines sometimes succeed in attenuating it, and thus promote its discharge; whilst acids and various astringent remedies check it when it is too profuse; but here blisters and various evacuants should be combined with these last, otherwise the inflammation may be increased. This corresponds with what has been said of the treatment of sthenic fluxes, (§ 393.) When the effusion is in cellular texture, a serous cavity, or parenchyma, it may more seriously interfere with the functions of the part; and it may be more important to prevent, or restrain, or remove, the effusion. Thus, in the submucous cellular texture of the glottis, or in the serous membranes of the brain, a little effusion may prove fatal; and in the lungs or pleura, effusions are injurious in proportion to their extent. Besides the measures directed against determination and vascular distension, it is doubtful that we possess means of restraining effusion. It is pretty certain that some other antiphlogistic remedies, especially mercury and antimony, do diminish the effusions of inflammation, and promote their re-absorption; but it is not clear that they do so in any more direct way than by reducing the local and general excitement, or by their evacuant effect. The expressions, "sorbefacient" and "exciting the absorbents," hypothetically ascribe to remedies the property of increasing absorption; but nothing in physiology points out any direct mode in which absorption can be artificially increased. A free action of the excreting organs promotes absorption, by reducing the distension of the vascular system. Absorption is also promoted by a circulation that is free, without excitement or distension;* and the return of the vessels to a healthy state is generally attended with more or less absorption of the effusions. It is probable that blisters and other counter-irritant applications near the inflamed part promote absorption, not merely as evacuants or derivants, but also by causing a rapid flow of blood through the adjoining vessels, which facilitates the endosmosis and removal of effused fluids. Hot fomentations and stimulant frictions seem to operate in the same way.

In various cases it is necessary to give vent to the accumulated

* In my Gulstonian Lectures, (Med. Gaz., July, 1841,) I adverted to the effect of a rapid current in promoting absorption. Mr. G. Robinson has lately illustrated this effect by some experiments, (Med. Gaz., May, 1843.) Another influence which probably contributes, is the different density of the fluid within and without the vessels: that within is more dense and saline, and by the law of endosmosis, tends to attract the thinner fluid from without. This explains the greater readiness with which the thinner effusions are absorbed. Can we increase absorption by rendering the blood more saline than usual? The thirst after taking salt food would seem referable to this cause.

effusion by surgical operation, as by incisions or acupunctures in erysipelas, opening abscesses, paracentesis in empyema, &c. This is chiefly necessary where the effused matter is purulent and little susceptible of absorption, as well as noxious to the system; but sometimes the mere quantity or situation of the effusion, by endangering life, renders the resource of an operation necessary, as in acute laryngitis and some cases of pleurisy.

497.—9. *Increased absorption* is manifest in the processes of softening, ulceration, and suppuration. I have endeavoured to explain how, in the midst of distended and effusing vessels, absorption is increased. The veins and lymphatics are free, and by the motion communicated to them from the current of the neighbouring and anastomosing branches, they are ready to convey away all the fluids that can pass through their coats, (Gulstonian Lectures, 1841.) In fact, this is doubtless a provision for the removal of superfluous matter, old and new; but the process becomes injurious and destructive when it predominates over effusion, and extensively invades the living textures. But we have found reason to suppose that textures do not fall a prey to the softening or ulcerative process, unless their vitality is lowered and their nutrition impaired by a defective supply or quality of blood, (§ 466, 7;) and that inflammation does produce these effects very differently in different cases. Sometimes local stimulants and general tonics check softening and ulceration by improving the vitality and nourishment of the obstructed part; but they may have the opposite effect if the circulation in the affected part is too much obstructed to admit of increase. Hence we find, in phagedenic ulcerations, stimulants sometimes check and sometimes aggravate the disease. The increased absorption which forms a part of ulceration might be arrested by diminishing atmospheric pressure on the part, as by applying a cupping-glass over a phagedenic ulcer; but such an expedient is rarely practicable.

498.—10. *Impeded circulation in the part* has been just adverted to as contributing, with increased absorption, to the processes of softening and ulceration; but its greatest effect is manifest in gangrene, or the complete death of the part. In suppuration, also, the part dies, but it is removed by absorption, and replaced by pus, which makes its way to the exterior. Of the few agents that may be directed to restore or improve obstructed circulation, heat is the chief one to be named. Heat enlarges vessels, especially arteries, (§ 120,) and facilitates the passage of blood through them; and although, for this very reason, hurtful in sthenic inflammation and in parts where determination prevails, it is really very beneficial in the stages and forms of inflammation in which obstruction predominates and endangers the vitality of the part. Hence the utility of hot fomentations or poultices in low forms or advanced stages of external inflammation. In slight cases, frequent applications of heat and moisture may entirely remove the obstruction, restore the circulation, and thus the life of the part, although the inflammation may have already caused much effusion. In other cases, heat does not remove the obstruction, and therefore does not maintain the life of the part; but by increasing the determination around it, it promotes its removal by suppuration, and it hastens and matures this process, which is the best by which a part, the circulation of which is obstructed, can be removed. In a similar way, too, heat favours the effusion of lymph, which circumscribes the suppuration and prevents it from spreading or infecting the system. Lastly, in a similar way, heat and other stimulating applications promote the process of separation or sloughing of a gangrenous part, (§ 475,) the whole circulation and life of which have ceased. These latter effects of heat may often be promoted by medicines and food calculated to maintain the vigour of the general circulation.

499.—11. *The increased circulation around the obstructed part* is often that constituent of inflammation which causes the most prominent symptoms, the greatest heat, pain, tenderness, and other marks of excited function being commonly dependent on it. We have already noticed determination as an element of inflammation in its early stage, and refer to that clause (4) for an account of the remedies with which it is to be combated. We now advert to determination to the neighbouring vessels as a part of the extending irritation of inflammation, which often sympathetically excites the whole system into fever. The treatment, therefore, partakes of the character of that suited for inflammation with fever.

Treatment of inflammation with fever.

500. The fever excited by inflammation consists chiefly of the items mentioned in the table; but it will be more convenient to notice them here together. They are—(12) *Excitement of the heart and* (13) *of the arteries;* (14) *change in the blood by increase of fibrin and* (15) *by diminution of the excretions.*

The addition of fever to inflammation very materially modifies the treatment. The disease then to be treated is not merely the inflamed part and a few other parts in sympathetic relation with it, but the whole vascular system, its blood and the secretions and functions which it supports. In like manner, the treatment must now become general instead of local; not because the local inflammation has lost its importance, but because it has now become a part of a general disease, which sustains it with such an energy that local remedies now become trivial, or even injurious. Thus, when inflammation is backed by febrile excitement of the heart and arteries, the stimulant and astringent antiphlogistic remedies (§ 491) irritate the distended vessels instead of making them contract. What can local blood-letting do when there is an excited force from behind impelling the blood to the inflamed part more rapidly than the oozing by local bleeding can relieve it? Derivants also have little power when the tension of the whole vascular system is so much raised. Counter-irritants must even prove injurious, by adding another cause of excitement to the system. So, too, narcotics can have no control over fever once established, and may prove hurtful by exciting the nervous centres, and still further impairing the secretions, (§ 166.) Under these circumstances, a more general remedy is wanted, which shall reduce the action of the heart and arteries, and diminish the inflammatory character of the blood. The first and most powerful remedy of this kind is general blood-letting; next come the stronger evacuants, antimony and mercury; and lowest in power are what are called refrigerants and direct sedatives. We shall briefly notice these antiphlogistic remedies.

501. Blood-letting, if carried far enough, is sure to reduce the action of the heart; for, as formerly explained, it may produce syncope, (§ 70.) A remarkable fact, first pointed out by Dr. Marshall Hall, is, that in inflammatory disease a much larger amount of blood may be drawn without producing syncope than can be taken in health or in other diseases. The following is Dr. M. Hall's table of the results of his investigation of the tolerance of blood-letting in different diseases. The numbers represent the mean quantity of blood which flows before incipient syncope in the sitting or erect posture:—

I. Augmented Tolerance:	
Congestion of the brain	℥ xl—l.
Inflammation of serous membranes Inflammation of synovial membranes Inflammation of fibrous membranes	℥ xxx—xl.
Inflammation of the parenchyma of organs, (brain, lung, liver, mamma, &c.)	℥ xxx.
Inflammation of skin and mucous membranes (erysipelas, bronchitis, dysentery)	℥ xvi.
II. Healthy Tolerance:	
This depends on the age, sex, strength, &c., and on the degree of thickness of the parietes of the heart; and is about	℥ xv.
III. Diminished Tolerance:	
Fevers and eruptive fevers	℥ xii—ʒ xiv.
Delirium tremens and puerperal delirium	℥ x—xii.

Laceration or concussion of the brain	℥ viii—x.
Accidents before the establishment of inflammation	
Intestinal irritation	
Dyspepsia, chlorosis	℥ viii.
Cholera	℥ vj.

The explanation of the increased tolerance of blood-letting in inflammation is, I apprehend, to be found in the increased excitability of the heart and tonicity of the arteries, which maintain a sufficient force and tension to preserve the circulation, especially through the brain, (§ 266,) even when much blood is lost. In asthenic or atonic diseases, on the other hand, the arteries being lax, and ill fitted to transmit the blood, a smaller loss is felt, and syncope may result. The variations between inflammations occupying different seats must be referred to the arterial tone being less augmented in some than in others, and are therefore indications of the more or less sthenic (§ 477) character of the inflammation. The quantity of blood in the whole system will affect the heart's action and arterial tension in a similar way; and no doubt the more stimulating quality of the blood may contribute to the same results.

502. The object of blood-letting in inflammation is not merely to produce syncope, or a temporary impression on the pulse, but a permanent reduction of the excitement of the heart and arteries; and this is to be effected in different modes of blood-letting under different circumstances. Where the inflammation is quite recent, and the fever has not existed long, a moderate amount of blood rapidly taken from a large orifice, or from two arms at once, or even from the jugular vein, will often be sufficient to reduce the fever and inflammation. The circulation is thus reduced, perhaps to syncope; and, relieved of the pressure and determination of blood, the inflamed vessels soon recover their normal state, if not spontaneously, at least with the aid of some of the subsidiary antiphlogistic measures. The benefit resulting from this mode of blood-letting in recent cases is sometimes very striking, and the cure is effected at a comparatively small expense of blood.

503. But the case is different when an acute inflammation and fever have lasted for two or three days. There is then not merely excitement, but sundry changes in the inflamed part and in the blood, which keep up the excitement; the inflammation has become established in the part, and the fever in the system; and no brief impression on the circulation, however sudden and complex, can remove them. If in this state a patient be speedily bled to fainting, reaction will soon come on, and renew the fever with increased intensity. Here, therefore, it is necessary to bleed more slowly and to draw more blood; and instead of promoting the occurrence of syncope by the erect or sitting posture, it is

proper to keep the patient in an easy recumbent or reclining position, and to watch for the good effect of the bleeding in the softening of the pulse, or the relief of the pain or other distressing symptom. The actual occurrence of syncope is rather to be avoided, and may be prevented by untying the arm as soon as the lips lose their colour, or the patient complains of feeling sick or faint. Thus practised, blood-letting causes a more prominent reduction of the active elements of inflammation and fever, diminishes the exciting and too fibrinous condition of the blood, and although it cannot repair the changes already produced in the inflamed part, it prevents their increase, and puts them in a condition favourable for the curative efforts of nature and the further operation of other antiphlogistic remedies. In the more severe and confirmed cases of inflammation it is often requisite to repeat the blood-letting again and again; the indication for this being the return of incompressibility of the pulse, heat of skin, and a new aggravation of the symptoms. In all such cases, the advantage of the gradual over the sudden mode of blood-letting is apparent, for where the reducing influence of this measure is longest sustained, it is least necessary to resort to it again.

Another case in which it is expedient to draw blood largely rather than suddenly is where inflammation is combined with plethora. On the other hand, in anæmic subjects, the blood should be economized as much as possible; the early depression from the loss of blood should be promoted by a posture favouring the occurrence of syncope, and might be sustained by the influence of antimony and other remedies.

504. After the general excitement has been lowered or removed by general blood-letting, the local inflammation often has to be treated by topical blood-letting, which now is not only more efficacious in reducing the determination and distension of the inflamed part, but contributes to keep down the general excitement. In fact, local blood-letting, as by cupping or numerous leeches, may be made so extensive as to be tantamount to general blood-letting; and the cases in which it has most of this effect are those in which slow bleeding answers best. In either extreme of age, and in the feeble, local bleeding only is admissible. Local blood-letting is chiefly suitable for inflammations which are superficial and extended, as those of the pleura or peritoneum. It is of much less avail in pneumonia, cerebritis, and other inflammations of deep-seated or parenchymatous organs.

505. Of other evacuants none are equal to purgatives, which are a great aid to blood-letting, and should be used in most cases of severe inflammation, uncomplicated with gastro-enteritic irritation. They operate on so large a surface that they affect the system, and their effect may be pushed to the extent of producing

syncope; but such an extreme result is attended with much exhaustion, and their continued use may cause intestinal inflammation. The chief benefit arising from purgatives may be obtained from a few efficient doses at the commencement of the treatment. This aids the depressing effect of blood-letting, removes fæculent matter, which is often a source of irritation, and clears the intestinal canal for the operation of other medicines. The stronger and less heating purgatives are to be preferred, such as calomel, jalap, salts and senna, combined with tartar emetic or colchicum. A combination of several, which operate most on different parts of the canal, answers best.

506. Of internal remedies against inflammation with fever, that which most resembles blood-letting in its effects is tartarized antimony. It is far less sure in its operation, and its influence is not proportioned to the quantity; yet under its use, especially if preceded by blood-letting, the pulse becomes less hard and frequent, the heat of skin is moderated, and sometimes perspiration ensues, whilst the local symptoms are generally more or less improved. Sometimes it causes vomiting, more rarely purging; but its best antiphlogistic operation occurs where these effects do not ensue to interfere with a continuance of the medicine; and I have frequently found its utility most marked when it did not cause even nausea or profuse diaphoresis. Tartarized antimony, and the milder preparation, James's powder, have been very long used in this country as febrifuge medicines; and Dr. Marryatt, who practised at Bristol in the last century, used the former in large doses for inflammation. The practice was since carried to a greater extent by Rasori, and other Italian physicians, who gave from 10 to 120 grains in twenty-four hours. Laennec adopted the use of the remedy in more moderate quantities, giving from one to four grains in some agreeable vehicle every second or third hour for six doses; then intermitting or continuing it, according to circumstances. In pneumonia and rheumatism, he considered it the chief remedy. Most practitioners in this country now consider tartar emetic a valuable aid in subduing inflammation, chiefly to be used after blood-letting; or in slighter inflammations, where blood-letting is inexpedient. I rarely find it useful to raise the dose beyond two grains every three hours; and in most cases one grain, half a grain, or even less, will suffice. The first doses sometimes cause vomiting; but this generally subsides when the doses are repeated, and may be prevented by giving the medicine in a mild neutral saline draught, with from five to ten minims of the diluted hydrocyanic acid in it. Antimony acts most satisfactorily in inflammations of vascular parenchymata and complex membranes; such as the lungs, the testicles, the mammæ, the air-passages, the cellular membrane and skin, and

the joints. It is less effectual in inflammation of serous membranes, and would be unsafe in inflammatory affections of the intestinal canal. It is most beneficial in the early stages of inflammation, especially when attended with fever; and seems to have little effect on the products of inflammation.

How antimony operates in reducing fever and inflammation is quite uncertain. Rasori considered it to be a direct sedative or *contro-stimulant*, diminishing the excitability of the vascular system, and thus neutralizing the inflammation. He supposed that the *tolerance*, or power of the body to bear large doses of the remedy, depends on the presence of inflammation in the system; but, as Laennec has observed, this is not correct; for patients that are quite convalescent have continued to take 12 or 18 grains daily without nausea, or even loss of appetite. Laennec first considered that the medicines act as a revulsive, by irritating the stomach; but this view being made, by the Broussaians, a ground of opposition to the use of the remedy, Laennec latterly represented it to act as a sorbefacient. It seems to me, that the most reasonable view to take of its operation is, that it chiefly acts by diminishing the tonicity of the vascular system, (§ 122.) Small doses certainly relax the pulse and skin, and, where there is no fever, produce perspiration without stimulating. They also seem to increase the biliary and intestinal secretion. In inflammation and fever, larger doses are required to produce the same result; and as soon as the excessive arterial tension is relaxed, the chief part of the fever is removed, (§ 441.) By thus reducing the increased tonicity of the arteries, the circulation is equalized and quieted, and the determination to and distension of the inflamed part are diminished; and the vessels generally are placed in the condition for their natural offices of secretion, which their extreme tension had before interrupted. This view is, however, at present, no more than hypothetical, and might with advantage be tested by experiments on the lower animals.

507. Another great remedy in inflammation is mercury, alone or combined with opium. The combination of calomel and opium was first employed by Dr. Hamilton of Lynn Regis; and the rules which he proposed for its use have hardly been improved on. After a sufficient venesection and a full purge, he gave from one to five grains of calomel with from one-fourth to one grain of opium every six, eight, or twelve hours. When much fever was present with dryness of skin, he added tartar emetic and camphor. If no relief ensued in twenty-four hours, venesection was repeated. Most practitioners admit the power of this remedy, although some ascribe its efficacy to the mercury, others to the opium; and the proportions of each have been variously altered. The beneficial effects of this remedy generally,

but not entirely, depend on the mercury affecting the system, as manifested in adults by the fœtor of the breath, and the tenderness and swelling of the gums; and in children, by spinach-like evacuations from the bowels. Improvement is, however, often manifest before these results take place. In iritis, the influence of mercury is quite visible in removing effused lymph; and it thus obviously in some way promotes absorption, as well as prevents effusion. The same "sorbefacient" operation is seen in the effect of mercury in removing the callous margin of indolent syphilitic ulcers, and in promoting the spread of phagedenic ulcers. Dr. Farre thinks that mercury destroys red particles of the blood, and causes in the system a disposition to erythematic inflammation, which is incompatible with phlegmonous or plastic; but this is opposed by the fact that lymph is thrown out, and granulations form and healthy ulcers heal during mercurial action. It will be useful to give briefly a view of the operation of mercury and opium; for although we cannot be confident as to its entire accuracy, yet it is founded on what is best known of the effects of these medicines, and may therefore be a guide in their administration.

The opium is useful in preventing the calomel from purging, and especially in subduing the nervous irritation attending inflammation, and which we have found to be one cause of that sympathetic excitement which, when complete, constitutes fever, (§ 440.) This salutary effect of opium alone is sometimes seen when the vascular excitement has been subdued by a large blood-letting, and in cases in which nervous irritation forms a chief element of the disease: here a full dose of opium will subdue the remains of the inflammation better than any other antiphlogistic remedy; it seems to paralyze those sympathies which are concerned in renewing or maintaining the excitement of inflammatory fever. So, too, in combination with mercury, the opium exercises this narcotic influence; whilst the mercury prevents its astringent effect on the secreting organs, (§ 66, 173.) The mercury acts further: it augments the biliary and intestinal secretions; sometimes inducing copious mucous and bilious evacuations; and from its effect in iritis, it may be presumed to facilitate the solution and removal of effused lymph. How it has this effect is quite uncertain; probably it is by changing the condition of the blood, by a diminution of the fibrin and white corpuscles, the increase of which is much concerned in contributing to the changes of inflammation. So we find mercury chiefly useful where the blood is very much buffed, and there is tendency to copious fibrinous effusions, as in inflammations of serous membranes and croup. Calomel and opium have little influence over high inflammatory fever; and the system thus excited generally resists the mercurial action. This remedy has no further sedative effects than those which proceed from its action on the intestinal canal; and unless to produce this action, it is not well adapted for the earliest stage and most active forms of inflammation. In these circumstances, blood-letting is more required with mercury than with antimony; and if fever returns during the action of mercury, blood-letting or active purging may be necessary to reduce it. In fact, the operation of calomel and opium is less antiphlogistic, and more alterative, than that of blood-letting or antimony: it is inferior to them in the power of reducing inflammatory fever and active inflammation; but it is superior to them in arresting and removing the more plastic products of inflammation.

508. As considerable aids in the treatment of inflammatory fever, although quite inefficient alone, must be mentioned various saline medicines, such as nitrate of potass, and the alkalies combined with vegetable acids. Diluted solutions of these allay thirst, and seem to cool the fever; hence they have obtained the title of refrigerants. It is uncertain how far they may operate in diminishing the cohesion and excess of fibrin in the blood, (§ 438;) but we can distinctly trace their good effect in augmenting the secretions, particularly that of the kidneys, (§ 256.) They are all more or less diuretic; and most of them also supply an alkaline base, which, by uniting to the lithic and lactic acids formed in the blood, facilitate the separation of these matters by the kidneys. Colchicum and digitalis are sometimes reckoned among antiphlogistic remedies; but in common inflammation, they are of very inferior power. In the absence of high fever, colchicum somewhat resembles mercury in its special action on the secretion of the liver, and it augments the elimination by the kidneys, (§ 257;) and digitalis acts as a diuretic, as well as a sedative on the irritability of the heart; but during severe inflammation, these effects are scarcely produced by doses which it would be prudent to administer.

509. The utility of counter-irritants as a remedy for several elements of local inflammation has been already noticed, (§ 493, 496;) but their operation is positively injurious in sthenic inflammation during the prevalence of fever. They then add to the excitement of the system; and in proportion to the inflammation which they excite, they prove a new source of the inflammatory changes in the blood, (§ 438.) But after the fever has subsided under the influence of remedies, or is exhausted by time, the advantage of counter-irritants returns. Blisters and suppurating counter-irritants, which cause copious discharge, are the most useful; tending to draw away the remains of inflammation, and to promote the removal of effused matters left by it. These become chief remedies as inflammation inclines to a chronic state,

or where it has left such structural changes as cannot be speedily removed.

510. It is not necessary to dwell on the last three items of treatment in the table, (16. Exhaustion; 17. Depression from poison; 18. Solid effusions.) The exhaustion ensuing after long-sustained excitement of inflammation and fever often renders stimulants and tonics, as well as a generous diet, necessary in the after treatment; but the greatest circumspection is necessary to be sure that these measures shall be proportioned to the wants of the case, and not pushed so early or so far as to rekindle the inflammation afresh, or to produce other disorder in the weakened organization. Similar aids are required, but are less successful in supporting the system against the pernicious influence of purulent or gangrenous matter resulting from the inflammation. Even in cases of suppuration, the occurrence of the premonitory rigors, the diminished strength of pulse and heat of skin, point out the time for changing the reducing plan for one more supporting; but the degree to which the change is made must depend on the symptoms and efficiency with which nature is attempting the process of limiting the destroyed part. It is probable that, in all cases, some purulent or some gangrenous matter finds its way into the circulation; therefore, in addition to stimulants and tonics, antiseptics (such as chlorinated liquids, nitromuriatic acid, and creosote) are sometimes with advantage given internally to counteract the septic influence; and the secretions are kept free to promote the elimination of the morbid matter, (§ 260.) For a similar reason, foul, suppurating, and gangrenous sores are dressed frequently, and their discharge corrected and promoted by antiseptic and alterative applications.

511. The removal of many of the products of inflammation (serum, liquor sanguinis, and the healthier kind of fibrin and exudation corpuscles, § 424,) is effected by the natural process of absorption, aided by various remedies before mentioned, particularly blisters and other counter-irritants, mercury, iodide of potassium, colchicum, and other diuretics. Products of external inflammation are sometimes more speedily dispersed under the influence of what are called discutients, which are generally slight stimulant applications, such as a warm spirit lotion, or solution of hydrochlorate of ammonia, common salt, or iodide of potassium; and in more chronic cases, by friction with liniments containing mercury, iodine, ammonia, and spirit. These operate in various ways already explained, by promoting the current of blood through the part, and thus facilitating absorption; by diminishing the atonic congestion left by inflammation; by promoting secretion or exhalation; by pressure, &c.

512. The *antiphlogistic regimen* consists in the exclusion of

all causes of excitement in the food which the patient takes, and in the circumstances to which he is exposed; such as light, noise, temperature, exertion, mental excitement, &c. The *diet* in active inflammation should be of the most sparing kind, consisting of mere diluents, tea, barley-water or thin gruel, whey, toast-water, soda-water, and the like: all stimulants, and articles abounding in the protein compounds, (§ 215,) or in oil, (§ 59,) being carefully avoided. When fever is present, the total loss of appetite is a sufficient guide to the necessary abstinence; and the stomach often will not retain or digest much nourishment, especially of a solid kind; but this is not the case in all cases of inflammation where the restraint is equally necessary.

TREATMENT OF VARIETIES OF INFLAMMATION.

513. The *sthenic* (§ 477) form of inflammation requires the whole array of antiphlogistic remedies to be directed with energy against it. The prevalence of determination of blood, active vascular excitement, and the over-fibrinous condition of the blood, demands the free use of blood-letting, purgatives, and antimony, at the onset; and the full operation of mercury if the disease continue. In *asthenic* inflammation, on the other hand, blood-letting is ill borne, and often can only be practised locally; and the chief treatment is with antimony or mercury, and blisters, which, in the absence of high fever, may be employed at a much earlier period than usual.

514. *Acute* inflammation (§ 478) demands a very prompt use of the suitable antiphlogistic remedies; but the choice made of them, and the extent to which they are to be pushed, will depend on whether the inflammation be sthenic or not. *Sub-acute* inflammation is generally of the asthenic form; and being less severe, as well as slower in its progress and effects, it does not require such active treatment. It must not, however, be neglected; for its obscurity sometimes renders it dangerous; and in an insidious manner, it sometimes seriously injures function and structure. Its long continuance, or liability to recurrence, renders it necessary to continue a moderate antiphlogistic treatment for several weeks. When lasting so long, it tends to become more asthenic, when the more lowering antiphlogistic remedies are no longer serviceable; and sometimes it is proper even to call in the aid of tonics and improved diet, whilst the local inflammation is treated with counter-irritants. Mercury with opium is generally one of the most useful remedies in subacute inflammation.

515. *Chronic* inflammation recedes still further from the inflammatory type, and borders more on congestion or disease of nutrition. The absence of fever generally supersedes the need of

the stronger antiphlogistic remedies—those for local inflammation being sufficient; general blood-letting is needful only when plethora also is present; and even local blood-letting should not be too freely employed; for it weakens the system, which is generally already too feeble in chronic inflammation. Counter-irritants are more constantly useful; and their application should be varied according to the seat and extent of the inflammation. In inflammations of serous membranes, a succession of blisters answers best. For chronic inflammations of parenchymatous organs, and ulcerations of mucous membranes, counter-irritants, which excite pustules, or setons, are of more avail. Mercury is often useful, and so are other alterative medicines, especially salines and the iodide of potassium. Mercury is more suitable to the more sthenic forms, attended with effusion of lymph, leading to tough thickening and induration of textures. Iodide of potassium is better adapted for chronic inflammation of an asthenic character, with reduced blood and strength, with tendency to ulceration, suppuration, or aplastic deposits. It is often requisite to keep up the general strength by the mildest tonics, such as sarsaparilla and mild bitters, and to allow a mildly nourishing, but not stimulating diet. Careful attention to the state of the excretions is particularly necessary. Courses of mineral waters, and change of air by gentle travelling, are often serviceable in chronic inflammations.

516. In *congestive* inflammation, (§ 480,) the treatment for congestion should be combined with that of subacute inflammation. If the subject be plethoric, general blood-letting would be proper; otherwise local bleeding and various derivants or revulsives, among which cupping and dry cupping are the most effectual. Rubefacient applications to an extensive surface, as large mustard poultices, and strong ammoniacal or mineral acid liniments, are of considerable efficacy; and their use can be renewed and varied daily for a long time. Mercury and antimony are both highly useful in the more active stage of congestive inflammations: the former especially for inflammations of the abdomen, the latter for those of the lungs. In the absence of much irritation, iodide of potassium, mineral acids, and even quinine, sometimes help to disperse the congestive part of inflammation. So, too, in secreting organs, as the liver, kidneys, and mucous membranes, various stimulants which excite the secretion act in a similar way. For further particulars, see the treatment of congestion, (§ 313, *et seq.*)

517. The treatment of *phlegmonous* inflammation* is generally

* This term is used here in the sense in which Cullen employed it, as opposed to erythematic or erysipelatous. I mention this, because boils or furun-

that for the sthenic form. *Erysipelatous* inflammation being generally asthenic, is not benefited by active antiphlogistic measures; and in some cases it is necessary to adopt quite an opposite treatment, by ammonia, wine, bark, &c.: this is where the influence of the specific poison (§ 482) predominates. In other cases, the reaction against this influence is very vigorous, and requires moderation. Generally warm fomentations to the affected parts, a saline, with small doses of tartar emetic, and keeping the secretions free, answer best at first, and are, in a few days, to be gradually replaced for ammonia or wine, and bark or quinine, with improving nourishment. A more decided counter agent against the poison (as against other animal poisons) is a desideratum; but cleanliness and careful regulation of temperature and ventilation, are the best preventives. Punctures and incisions, which relieve the inflamed part by the discharge of blood and morbid matter—and by nitrate of silver, which, by exciting adhesive inflammation, arrests the progress of the erysipelas—and mercurial ointment, which is supposed to modify its character,—are the chief kinds of local treatment that have been found useful.

516. *Pellicular* or *diphtheritic* inflammation is usually of an asthenic character, little benefited by blood-letting, but chiefly to be counteracted by mercury, which is the suitable remedy for all inflammations effusing lymph; and by local astringents, or even caustics, which, by powerfully exciting the vessels, change their action. Thus nitrate of silver, in substance and in solution, hydrochloric and diluted nitric acids, (one part to three or four parts of honey applied with a brush,) and finely powdered alum, have been used with advantage in diphtheritic sore throat. In the croupy inflammation of children, the most effectual remedies are, calomel freely used, antimony, and certain expectorant or attenuant medicines, which promote the more liquid secretions of the inflamed membrane. The aphthous inflammation of children is readily subdued by a solution of borax, or a weak solution of sulphate of zinc, using at the same time magnesia and mild mercurial aperients to correct the secretions of the alimentary canal.

517. *Hæmorrhagic* inflammations (§ 484) are often of the congestive kind; and the hæmorrhage arises from the excessive distension of vessels, as in the hæmatemesis that sometimes precedes gastritis, the bloody discharges of dysentery, and the hæmaturia which occasionally ushers in inflammation of the pelvis and the tubes of the kidney, (pyelitis.) The hæmorrhagic tendency exhibited in purpura, and sometimes combined with in-

cular inflammations are sometimes of an asthenic character; and with them not unfrequently the constitution requires support.

flammation in lichen lividus, and ecchymosed erysipelas, I have often found connected with congestion and torpid action of the liver, (§ 171,) and accordingly benefited by mercurial and saline aperients, followed by nitric or nitromuriatic acid.

518. *Scrofulous inflammation* (§ 485) being generally asthenic, is little benefited by blood-letting or other active antiphlogistic measures. Its disposition to produce early cacoplastic and aplastic effusions makes it important that it should be subdued, if possible, at an early stage, in situations where the formation of curdy pus or tuberculous matter would be injurious. In scrofulous inflammation of the lymphatic glands, warmth and moisture, and discutient applications, (solutions of muriate of ammonia, iodide of potassium, warm vinegar,) are often useful in dispersing the swelling before it comes to suppuration. In internal inflammations in scrofulous subjects, (as of the lungs, glands, and joints,) local depletion is generally advisable, followed by free counter-irritation, especially such as may cause an external discharge of pus. Dr. O'Beirne and others recommend a free mercurial course for scrofulous inflammation; but this I consider admissible only in the earliest stage of the disease, and in its more active forms; for I have found (what I believe is the experience of most practitioners) that mercurialization greatly injures the constitution of scrofulous subjects; degrades the products of inflammation, and promotes softening and ulceration in textures where deposit has already taken place. It seems to me, that it is rather asthenic or chronic inflammation, (§ 479,) in subjects that are not scrofulous, that is benefited by mercury, and not that especially occurring in the scrofulous diathesis. Preparations of iodine, especially the iodide of potassium, do sometimes appear to countervail low scrofulous inflammation; and their commonly salutary operation on the constitution renders them eligible medicines in scrofulous subjects.

But the source of the peculiarities of scrofulous inflammation, and therefore the chief object for peculiar treatment, is the scrofulous diathesis or constitution; and as this seems to consist in a degraded condition of the plasma, or nutritive material of the blood, (§ 211,) often connected with a deficiency of red particles, (§ 185,) an invigorating and nourishing treatment and regimen are especially indicated, (§ 218, 219,) and may sometimes be employed even when low inflammation is present, this being counteracted by counter-irritation or other local antiphlogistic measures. Hence the best remedies in scrofula are tonics, nourishing diet, and other means calculated to improve the nutritive function and general health. Of medicinal agents, the iodides of potassium and iron, and other preparations of iron, bitters with alkalies, bark or quinine, and mineral acids, have been found the best aids.

But still higher in efficacy are pure and mild air, especially near the sea or on mountains; warm clothing; regular exercise; warm sea-bathing, or cold when borne, (§ 79,) followed by friction; a good proportion of wholesome animal food, with due regard to the state of the excretions. These measures are of great efficacy in the scrofulous diathesis, and are often useful even after inflammation has producea disease; for they do much to prevent its increase, and assist nature in removing or rendering inert the cacoplastic or aplastic matter.

519. The peculiarity in the treatment of *rheumatic* and *gouty* inflammation consists chiefly in the use of means calculated to eliminate the morbid matter, which is its cause, (§ 251—254,) from the system. The remedies which best promote this object have been already mentioned, (§ 252, 254.) But it must be remembered, that the inflammation and fever excited may be so high and sthenic, as to require active antiphlogistic measures before colchicum or mercury can be made to act; and this is particularly the case in acute rheumatism, in which inflammation is excited in many parts at once; and probably as a consequence, (§ 438,) the blood becomes surcharged with fibrin. Here general blood-letting is necessary, not to remove the cause of the inflammation, but the inflammation itself. If after blood-letting the rheumatic cause abound still in the blood, which is commonly the case, it is proper then to give colchicum with alkalies, or iodide of potassium, or nitre in large quantities much diluted, (Gendrin,) and to continue such remedy for some time, until the morbid matter shall have been sufficiently eliminated. In asthenic cases, the use of bark, quinine, or other tonics, may be serviceable in improving the tone of the vessels after the irritation and exhaustion which the disease and its treatment have produced, (§ 174.)

520. The infectious character of *gonorrhœa* and *syphilis* proves the specific nature of their cause; but it is only of the latter that we can speak of a specific remedy. How mercury cures syphilis is quite uncertain. It is not by any property directly destructive of the virus; for the disease cannot be prevented from appearing by mercurial action; and when present, it is not always cured by it. It is more probable that mercury acts as an alterative, by removing the callous indurations of syphilitic sores and swellings, and by increasing the secretions, and thus gradually eliminating the syphilitic virus from the system. It is now well known that other remedies, which promote absorption and secretion, also promote the cure of syphilis, especially the iodide of potassium. Gonorrhœal inflammation generally tends to a spontaneous cure in a few weeks' time; but this may be accelerated by mild antiphlogistic and demulcent measures at first, and astringent injections and terebinthinate remedies subsequently.

SECTION VIII.

IDIOPATHIC FEVER.

[That combination of symptoms known as fever has been described, (§§ 437, 438, 439, 440, 441, 442, 443, 444,) in connection with inflammation, and treated of as a consequence of it. We have now to consider fever as a general idiopathic affection, whose essential phenomena are wholly independent of any local inflammation.

Some of the more prominent reasons for regarding fever as essentially distinct from the constitutional effects of inflammation will be now briefly adverted to. The characteristic symptoms of fever, the causes by which they are developed, the special nature of the alterations which occur in the solids during their progress, and the epoch at which they happen often posterior to the febrile movement, are sufficient reasons for not confounding fever with the immediate results of inflammation; a still more cogent argument has recently been added by the analysis of the blood in the two disorders.

I. The symptoms of idiopathic fever are chilliness, and lassitude, followed by subsequent reaction, with often long continued acceleration of pulse and heat of skin, and attended with thirst, anorexia, general uneasy sensations, and disturbance of all the functions. All these phenomena may occur without the evidence of any local inflammation in the entire course of the disorder, and without any conclusive signs of its previous existence being revealed on examination after death.

Some fevers from their commencement, present no symptom of gravity, and seem to proceed naturally towards a favourable termination. Others, from the invasion, or early in their progress, show that the organism is so much affected that cessation of the vital functions must necessarily result. The class of symptoms belonging to this condition are called *typhoid*, and are peculiarly prominent in typhus, and constitute its essence, but may supervene in the course of other varieties of fever. They are shown by a feeble, compressible pulse; by diminution in the secretions indicated in the dark, dry, and viscid coating of the tongue and mouth, the complete anorexia, and the dryness and even pungency of the skin; by the great implication of the nervous system, exhibited in dullness and confusion of intellect, excessive prostration, involuntary muscular spasms, obtuseness of the senses, particularly that of hearing, and the peculiar low muttering delirium in the advanced stages of the disease; the frequent presence of specific affections of the skin, characteristic of certain varietes of idiopathic fever; and finally the peculiar condition of the blood, with its decided tendency towards hæmorrhages, petechiæ, and other signs of what was formerly called putridity. These typhoid symptoms when they supervene in the course of other or local disorders, always imply the action of some cause on the system, distinct from local inflammation. Another distinguishing character of idiopathic fever is the great tendency to *spontaneous favourable termination.*

"In many cases the febrile symptoms return at regular intervals of 24, 48, or 72 hours; and subside completely after a cold and hot fit of some hours' duration, by a spontaneous sweating,—constituting the *intermitting* form of fever. In others there are equally distinct, but less perfect and less regular remissions of the symptoms, and the term applied is *remittent* fever. And in the remaining or *continued* form of idiopathic fever, although we can observe only slight and partial abatement of the symptoms at different hours of the day, we very often observe complete recovery from the most urgent and distressing symptoms, taking place spontaneously at various periods of the disease,—sometimes, in the fever of this country, as early as the 7th or even the 5th day; sometimes not until the 30th, or even 40th day, most generally between the 10th and 20th; sometimes very rapidly, and with evacuations (whether at regular or irregular times) evidently resembling the sweating stage of intermittents; sometimes gradually, and without any such critical evacuations; but under very various treatment,—often without the use of remedies,—and always with less assistance from remedies, and with much less risk of subsequent organic disease, than where recovery takes place from an equally disordered state of the system, consequent on decided internal inflammation."*

II. The causes of Idiopathic Fever are not of constant and universal operation, as are those of inflammation. They occur in certain localities, cease for a time, and recur under various circumstances, (§§ 88, 89, 90,) thus proving them to result from some local and temporary agency. And we have good reason to believe that all idiopathic fevers either originate from malaria (§§ 82, 83, 84, 85, 86,) or propagate themselves in part at least, and in certain circumstances by contagion (§§ 93, 94, 104), (*Alison.*) We know that certain conditions are favourable to the development of the disease, and that those who are in constant communication with the sick are liable to be, and frequently are attacked.

III. It has been stated that idiopathic fever may occur and proceed to a fatal termination with all the organs devoid of any appearance of disease. That the morbid changes most frequently met with in fever are to be regarded as its consequences rather than its causes, is rendered probable from many circumstances.

* Alison's Outlines of Pathology, p. 394.

In many cases the local appearances after death are to be ascribed rather to congestion, than to decided inflammation; a state which corresponds with the ascertained condition of the blood hereafter to be described.* All the recognized concomitant inflammations in fever are essentially modified by it. If an individual suffering from inflammation of the skin be attacked with fever, the appearance of the former will be altered, and if effusion have occurred, it will be suppressed. There is, moreover, no correspondence between the intensity of the constitutional symptoms, and the amount of local disease; the disorder may have been very severe, and after death such slight marks of inflammation may be detected, as by no means to justify the fatal event. The appearances of inflammation, after death, correspond often with symptoms developed just antecedent to death, and not referable to the earlier periods of the disease; the accession, and a considerable portion of its progress being entirely independent of them. The locality of inflammation in fever is variable, no one organ being constantly affected. Another evidence of want of identity between fever and inflammation is the result of certain methods of treatment. The usual amount of evacuation so useful in simple inflammation, when employed to combat local affections in fever, is usually borne less well; its effects are slight or null, or it is positively injurious.

IV. The peculiar state of the blood often, though, perhaps, not uniformly observed in fever, is directly inverse to that which we have seen invariably to be present in inflammation, (§§ 205, 213, 404.) According to Andral, the fibrin in fever uncomplicated with inflammation never increases. It remains at the physiological standard, or diminishes, and that to a degree never met with in any other acute disease. The most common complication of continued fever (that of inflammation of the intestinal mucous membrane and its glands) and the eruptions in the exanthemata, have no effect in increasing the fibrin. Every form and variety of

* A frequent coincidence in fever is the diminution of the fibrin of the blood, and the facility with which congestion (so often confounded with genuine inflammation) is produced. The circulating mass being deprived of its ordinary quantity of fibrin, the red corpuscles seem to lose at the same time the power of regulating their movements, and accumulate and stagnate in the capillaries. There is a peculiar congestion, which according to Andral is invariably connected with the typhoid state, whatever the disease may be. Its seat is the spleen, which becomes remarkable both from the increase in its volume, and the diminished consistence of the matter which fills its cells. Softening of the spleen in such cases is not due to any alteration of the tissue itself, for when by washing, the organ is empted of fluid, it is found natural. It is the contained matter which has lost its consistence, and this is coagulated blood, retained in the areolar tissue of the spleen. Like all blood poor in fibrin its coagulation is imperfect. The same condition of the blood in similar states is found in the clots in the heart and great vessels. Hence the enlargement and softening of the spleen which accompanies all well-marked typhoid symptoms may be considered as the effect of the diminution of the fibrin of the blood.—(*Hematologie Pathologique*, p. 71, 1843.)

fever, in every degree of intensity, will arise with every possible proportion in the globules. We never have the blood buffed in simple fever, in continued fever, variola, scarlatina or rubeola: (Andral). The specific cause which produces fever acts upon the blood in such a manner as to tend to destroy the coagulable principle.

The Pathology of Fever. From what has been said we are entitled to assume that there is the strongest presumption for the belief, that what has been called Idiopathic fever is specifically distinct from local inflammation. The concurrent testimony of an examination into the phenomena of fever, shows that the description given many years ago, by Fordyce, is a correct one. "A fever is a disease which affects the whole system; it affects the head, the trunk of the body, and the extremities; it affects the circulation, the absorption, and nervous system; it affects the skin, muscular fibres, and the membranes; it affects the body, and affects likewise the mind. It is therefore a disease of the whole system, in every kind of sense. It does not, however, affect the various parts of the system uniformly and equally, but on the contrary, sometimes one part is much more affected, compared with the affection of another part. Sometimes those parts which were most affected at one time, are least affected at other times; so that the appearances which are the principal ones in one fever, are by much the slightest in another, or sometimes are totally absent." (Fordyce on Fever, 2d Amer. ed., p. 16, 1823.) From the nature of its cause, the agency of some poison, probably sometimes engendered within the system, but most commonly derived from without, it is most probable that its influence is exerted on the system throughout. With regard to the morbific cause which produces and maintains the peculiar characters of febrile phenomena, some important points are to be considered.

"It may be questioned whether the effect on the nervous system, essential to fever, is produced directly by the external cause of fever, or whether that cause first works a change on the blood, and through its intervention affects the brain and nerves.

"It is plain that the blood is changed, at least as to its power of coagulation, in most cases, and probably it may be so in all cases of idiopathic fever. But a similar change as to that property may be produced in it, by causes acting in the first instance on the nervous system; and this fact, therefore, does not indicate the part of the system which is primarily affected in fever.

"Reasons which appear, on first consideration of the subject, satisfactory, may be given against the supposition of many of the older pathologists, that fever essentially and exclusively *consists* in a certain change in the blood (quæ præsens morbum facit, sublata tollit, mutata mutat); in particular, two facts already stated, viz. 1. That after the morbific cause has been applied to the blood, it may depend, as we believe, on causes acting on the nervous system only, whether or not it shall produce its specific effect; and, 2. That even after that specific effect has been produced, and the febrile actions begun, they may, in a few instances, be arrested by means (such as the cold affusion) which neither evacuate any part of the blood, nor alter its composition. But when it is distinctly understood that the change in the blood, believed to be morbific, is not in its chemical constitution simply, but in the vital qualities by which that constitution is constantly regulated and maintained, these facts have not the weight against the humoral pathology of fever, which has been ascribed to them.

"At least it may be thought, that the remote cause of fever does not produce its effect by merely once impressing the nervous system, or other living solids; but that it must necessarily affect for a time the fluids of the body, and perhaps multiply itself in them, in order that it may take effect on the solids. And in favour of *this form* of the humoral pathology of fever, the following facts may be stated.

"1. In a great majority of the cases in which we see typhoid fever, we are sure that some peculiar matter, generally absorbed from without, must be contained in the blood; as in the case of fever from malaria, from contagion (whether of simple fever or the eruptive fevers) from inflamed veins, from animal poisons introduced by wounds, or from suppression of the natural excretion at the kidneys. That this peculiar matter, or the blood altered by it, should act like a ferment, assimilating much of the circulating fluid to itself, in the former case equally as in the latter, is quite in accordance with what has been observed, when purulent matter has begun to form in the blood. (See Gulliver's Translation of Gerber, p. 104.)

"2. In all cases of idiopathic fever, as well as of the eruptive fevers, an interval, which is variable and often long, necessarily elapses between the application of the morbific cause, and the development of the fever; which is easily understood on the supposition that a change is gradually wrought on the blood during that interval, but not on the supposition of the poison acting simply on the living solids.

"3. In a great majority of cases of typhoid fever, we know that a matter, similar in its effects on the human system to that which excited the disease, is ultimately evolved in large quantity from the blood, making the disease contagious; *i. e.* the morbific poison in one way or another is multiplied in the blood of the living body.

"It has been naturally supposed by pathologists at different times, that the frequent and rapid abatement of fevers, after critical evacuations, is farther proof of the doctrine of their cause residing chiefly in the blood; and that this morbific cause is really carried off by these evacuations. And in support of this opinion, it has been stated, that when putrid matters, or diseased secretions, have been injected into the veins of animals, and excited febrile symptoms, a peculiarly fetid diarrhœa has preceded the recovery from these.

"But when it is considered, 1. That copious or spontaneous evacuations (*e. g.* of sweat) at the critical periods of fevers, often take place without the least good effect, if unattended by other marks of restoration of the natural condition of the capillaries; 2. That many fevers abate spontaneously and perfectly without crisis; 3. That in all contagious diseases, morbific effluvia escape for a long time from the body, without any good effect; 4. That there is no evidence of the critical evacuations possessing more contagious property than the effluvia which continually escape without advantage; and *lastly*, that in small-pox in particular, experience has shown, that the morbific matter in the pustules may be evacuated as quickly as it appears, without benefit, and may be reabsorbed into the blood without injury;—we must think it doubtful whether the critical evacuations are the *cause* of the solution of the fever that succeeds them, or whether we ought not rather to regard them as the *sign* of the restoration of the natural state of the vital actions in the capillaries of the body; whereby the excited action of the heart is enabled to throw off an unusual quantity of secretions and excretions, and then subsides; because the cause confining the circulation, and therefore stimulating the heart, has ceased to operate.

"The doctrine of the existence of a morbific matter in the blood, therefore, is not established by the facts as to the critical evacuations, but must be rested on the other facts above stated." (Alison, pp. 438—441.)

In whatever manner the circulation is affected in fever by the morbific agent, "it is to the direct action of this cause, and not to the influence of any local diseased actions, excited in the body, that we must ascribe the enfeebled state of the circulation—the altered state of the blood—the peculiarly vitiated state of the secretions—and in a great measure also, the deranged state of the nervous system which were described as characteristic of idiopathic and especially of typhoid fever."*

It has been suggested by a recent writer, (Alison,) that the morbific cause after existing for some time in the fluids, and perhaps multiplying itself, may act simultaneously on the constitution of the blood, on the vital affinities in the capillary vessels, on the powers of the heart, and the vital action of the brain

* Alison, p. 442.

and nerves. The peculiar depressing influence of the morbific cause on the system generally, corresponds with those instances where the blood is undoubtedly altered, by the introduction of foreign matters either introduced from without or generated in the circulating fluid; as glanders, purulent infection, diabetes, granular kidney, &c.

It must be borne in mind that certain concomitant local affections accompany certain cases of fever, or entire epidemics, or even very generally some species, complicating them materially, and increasing the danger. They may be divided into affections of the brain; affections of the chest; and affections of the abdominal viscera.

Very generally the affection of the nervous system in fever is by no means simple inflammation, yet it is sometimes accompanied by that variety called sub-acute; at other times no morbid appearances will be found to correspond with the cerebral symptoms during life.

In the respiratory organs, the serous membrane is rarely involved, but the bronchial mucous membrane and the substance of the lung are liable to inflammation. The peculiar condensation of the lower part of the lungs in the latter stage of fever is distinct from true hepatization.

In the abdominal viscera the inflammation and subsequent ulceration of the mucous membrame and its glands, is perhaps the most common complication in this country in continued fever. The spleen, as before remarked, is enlarged, and apparently softened. The stomach and liver, in some varieties of fever, and in hot countries, are frequently involved.

There are three distinct fatal terminations in fever, owing to the depressing influence of the morbific cause on the circulation, in combination with the deranged condition of several vital organs, consequent on inflammation. "These are, 1. The death by *Coma*, referable partly to the peculiar action of the cause of fever on the brain, but partly also to increased determination of blood thither, or inflammatory action or effusion there; 2. The death by *Asphyxia*, referable partly to the enfeebled state of the circulation, and want of power in the heart to propel the blood through the lungs, but partly also to bronchitis or pneumonia. 3. The death by mere *Asthenia*, referable partly to the deleterious effect of the morbific cause on the circulation, but frequently also in part to various local inflammations, prolonging the febrile state; and especially to the inflammations and ulcerations in the mucous membrane of the intestines, which appear to have in this, as in other cases, a peculiar sedative, and what was formerly designated as a sympathetic, effect on the heart's actions."*

* Alison, p. 444.

Treatment of Fever.

Idiopathic fever runs a certain course, and as it appears, tends naturally to a favourable termination. We have no means by which we can cut fevers short, or materially abridge their course. Our treatment must be subservient and auxiliary. We must endeavour chiefly to protect the functions essential to life from serious injury; or, in the language of Cullen, "obviate the tendency to death."

The patient must be placed under circumstances which will favour the decline of the disease, and he must be withdrawn from the influence of all causes which may aggravate the febrile state. "It is to be remembered," says Dr. Alison, "that when patients are placed in the circumstances above stated, a great majority of them, in most epidemics, especially if young, and previously healthy, will pass through the disease favourably without any farther treatment; and that powerful remedies, of any kind, may materially injure the course of the symptoms that is to be expected; therefore, that we should see clearly before us, some change that is likely to be injurious, and that some remedy fitted to counteract it,—and should look forward, besides, to the effect to be expected from that remedy on the ulterior progress of the symptoms, before determining on farther interference; excepting only by such placebos as may seem necessary for the satisfaction of patients or their friends."

Any peculiarities of type in the prevailing epidemic are to be noticed and regarded. Local complications, the chief source of anxiety and danger, are to be carefully watched; it being always borne in mind that concomitant inflammations in the course of fever are, as was stated, materially modified by the primary disorder; that evacuants are, as a general rule, but illy tolerated, and their effects widely different from those resulting from their use in idiopathic inflammations of the same organs. The state of the circulation should be constantly regarded, and its indications immediately attended to, in order to prevent fatal asthenia. In those epidemics where debility is a prominent feature this condition should be anticipated, and guarded against by appropriate means. Mild nourishing food given frequently in small quantities, with the use of stimulants, constitute our chief reliance.

The entrance on convalescense is one of the most critical periods in fever, and must be carefully watched, both from the tendency to relapse, from exposure, fatigue, or errors in diet, as well as the liability to the development of latent inflammations, particularly of the chest.—C.]

CHAPTER IV.

STRUCTURAL DISEASES OR DISEASES OF NUTRITION.—ULTIMATE AND PROXIMATE ELEMENTS.

SECTION I.

NATURE AND CLASSIFICATION.

521. Although we have had frequent occasion to advert to the changes in the process of *textural nutrition* effected by inflammation, congestion, &c., and although nutrition might be included under the head of *secretion*, (§ 178,) a primary element, yet it has seemed better to defer the notice of diseases of nutrition until now; both because the previous consideration of disorders of the blood and its vessels gives the best introduction to them, and because we cannot strictly distinguish structural disease into ultimate and proximate elements. By analogy, indeed, we might infer that ultimate structural disease is that which affects elementary structures singly, such as muscular fibre, nervous matter, cellular texture, &c.; but we find structural disease rarely to be thus confined to one anatomical element, but rather to affect structures as they exist in more or less complexity.

It will not be consistent with the plan of this work to give the details of structural disease, which belong rather to the department of morbid anatomy. It will be sufficient for our purpose to notice the chief forms of diseases of structure by tracing them through the alterations in the function of nutrition which produce them. This method will enable us to class these diseases in a natural arrangement, and under each head to state briefly what is known with regard to their nature and origin, and the remedies which influence them.

As in the case of functional diseases, so of structural lesions, which are modifications of the function of textural nutrition, they may be comprehended under the three heads, *increased*, *diminished*, and *perverted* nutrition.

ELEMENTS OF STRUCTURAL DISEASE.

- DISEASED NUTRITION
  - Increased = hypertrophy
  - Diminished = atrophy
  - Perverted . . .
    - Induration.
    - Softening.
    - Transformation.
    - Deposits
      - Euplastic
        - Cicatrices.
        - False membranes.
      - Cacoplastic
        - Cirrhosis.
        - Fibro-cartilage.
        - Gray tubercle.
        - Atheroma, &c.
      - Aplastic
        - Yellow tubercle.
        - Calcareous matter, &c.
    - Growths
      - Non-malignant
        - Cysts.
        - Tumours.
        - Hydatids, &c.
      - Malignant
        - Carcinoma.
        - Encephaloma.
        - Melanosis, &c.
- ALTERED MECHANISM
  - Contraction
  - Dilatation
  - Obstruction
  - Compression
  - Displacement
  - Rupture, &c.

522. It is not possible to enter fully into the minute or microscopic nature of these different modifications of structure, for observation has not yet supplied sufficient facts for such a detail; a general view derived from the more obvious characters of structural diseases will suffice for our present purpose. It must be remembered that the division here given, simple as it is, is too precise to be rigidly applicable to many cases. Lesions of nutrition often graduate into each other, and are very commonly combined; hypertrophy of some textures frequently co-existing with atrophy of others, perverted nutrition being often combined with excessive or defective, and several of these different changes often occurring in succession in consequence of the operation of the same cause. We have already found this to be the result of inflammation, (§ 479;) and inasmuch as that process exaggerates the changes of nutrition, it has furnished us with many examples of the production of structural lesions. What we now have to notice, are those changes, which take place independently of distinct inflammation, and which are mere modifications of that process of nutrition or reparation which is continually going on in the textures of the living body.*

523. As in inflammation, so probably in the ordinary process of nutrition, the material of which the organized solids are formed is the fibrin of the blood. This, by the formation of nucleated

* For the best summary of our present knowledge on the subject of nutrition see Dr. Carpenter's "Human Physiology."

cell-germs, and fibres, constitutes the basis of textures, which are afterwards further modified by growth and multiplication, and by the deposition of homogeneous or hyaline matter in their interstices. Some structures are chiefly formed of the nucleated cells pressed together and consolidated in rows and layers, as in the epidermis and the epithelium of mucous membranes. In other textures, the cells elongate into fibres, as in cellular texture and its modifications, serous membranes, fibrous and tendinous structures. In other textures, as cartilage and bone, the chief material is an amorphous solid deposit in an organized fibrous or cellular structure already formed. In the first formation and growth of textures, the production and multiplication of cell-germs from the plasma of the blood is necessary; and it is interesting to observe that in young animals, in pregnant females, and in the subjects of inflammation, the colourless corpuscles in the blood, (§ 212,) which probably are cell-germs, are much more numerous than usual, (§ 418.) But in the ordinary textural nutrition of adult animals there is less need of the formation of new cell-germs; those already existing in the texture maintain the process by drawing nourishment from the blood-liquor, which furnishes the materials of all the solid textures; the formation of new cell-germs thus normally diminishes as age advances, and when then increased it is usually the result of disease. Nutrition in all its stages is essentially a vital process: the formation of cytoblasts or cell-germs, their growth into cells, their power of separation or secretion of certain matters from the blood-liquor, their power of reproduction, all are properties peculiar to living matter, and are to be regarded as ultimate facts or elements in physiology. When their laws shall have been more fully studied, we may hope to trace to these elements, varied in proportion and kind, corresponding elements in pathology, which will explain much that is at present obscure in the origin and nature of structural diseases. But we must now be content with a more superficial notice of these lesions.

524. As nutrition depends on the blood for its material, and on the supply of arterial blood for the activity of the process, so it may be anticipated that changes of nutrition commonly arise from differences in the quantity and quality of the blood, and from variations in its arterial character. Hence diseases of nutrition are usually connected with diseases of the circulation and of the blood, (§ 269,) a moderately active circulation and a rich blood favouring nutrition; a poor blood (§ 260) and either too active or too feeble a circulation, impeding it; and a diseased quality or proportion in the elements of the blood (§ 186, 211) rendering it depraved. These causes operate on the whole frame; but they commonly affect some textures more readily

than others, because the process of nutrition is naturally more active, and therefore is more speedily influenced in some than in others. Thus fat and cellular textures are increased or diminished sooner than muscle, muscle sooner than tendon or bone, &c.; and for similar reasons degenerations and other changes of structure affect some parts more than others, (§ 311.) But structural diseases are more commonly partial, from causes existing in the part; and no causes are more common than those which affect the circulation of the part, so that partial anæmia, congestion, determination of blood, and inflammation, are the most frequent causes of partial structural disease. We have made a similar remark of diseased secretion (§ 159) and other elements of disease. If the nervous influence affects nutrition, it is probably through its operation on the circulation of the part. Thus a paralyzed limb wastes because, not being exercised, it is not so freely supplied with blood. The muscles of the limb of a frog, the nerves of which are divided, lose their irritability and waste also; but Dr. John Reid has shown that by exercising these muscles by electricity, which promotes the circulation, both their irritability and nutrition are maintained.

SECTION II.

INCREASED NUTRITION.—HYPERTROPHY.

525. Hypertrophy, as a disease, is always partial; for although the whole body in cases of obesity acquires an enormous bulk, this is from the extraordinary growth of the adipose tissue, a part only of the frame. When the nutrition of textures generally has reached the acme of full health, there is no more increase, and the superfluous nutriment accumulates in the blood-vessels, causing plethora, (§ 276.) Hypertrophy may affect *individual textures*, or *whole organs* composed of many textures: in the former case, it may be called *simple hypertrophy*, (an ultimate element of structural disease;) and in the latter, *complex hypertrophy*, (a proximate element.) Let us mention a few examples of each.

526. Muscles become enlarged by full exercise alternated with sufficient repose, and a healthy condition of the blood. This increased development in the voluntary muscles generally cannot be called disease; but I have seen it occur in the sterno-cleido-mastoid muscle, long the seat of convulsive motion, and by giving too great power to the muscle, it seemed to perpetuate the distortion. The best cure for this would have been Dieffenbach's operation for dividing the muscle, as in the case of squinting, in

which certain muscles gain too much power and probably bulk. But muscular hypertrophy is chiefly morbid when it affects involuntary muscles. Thus, in the heart, it results from continued excitement in sthenic subjects; and from the violence with which the enlarged heart moves and propels the blood, it produces various bad effects. The muscular fibres of the bladder become hypertrophied in case of enlarged prostate, or other cause of difficult micturition: those of the stomach are so from stricture of the pylorus; those of the bronchi are in chronic bronchitis, and dyspnœa is the result.

527. Hypertrophy of the interstitial cellular textures of the lungs, liver, &c., occurs after long-continued congestion from disease of the heart, &c. (§ 311.) In the cellular texture of the lower extremities it appears to be a chief constituent of elephantiasis. Hypertrophy of the epidermis occurs in callosities of the skin, and corns, from continued irritation or pressure, which causes determination of blood to the part. Another form of hypertrophy of the cuticle is that arising from chronic inflammation in psoriasis, chronic eczema, and impetigo. The cuticle is here retained, and from its stiffness it often cracks into chaps or rhagades. In the more temporary or more superficial cutaneous flushes, congestions or inflammations of erythema, scarlatina, lepra, and pityriasis, the superfluous epidermis is thrown off in a peeling of the skin, or in detached scales. But ichthyosis presents the most extraordinary instance of hypertrophy of the epidermis, its scales accumulating in a solid state, so as to form scales, or coarse bristle-like projections. These affections of the epidermis have their parallels in diseases of mucous membranes; but the secretions of these membranes being fluid, the nucleated cells, which on the skin would form solid scales, here are thrown off in the mucus, which presents an increased number of epithelium scales, as well as the exudation corpuscles and a viscid amorphous fluid, (§ 455.) Such disordered secretion of the mucous membranes not unfrequently coexists with cutaneous diseases; thus, bronchial congestion with viscid secretion occurs in persons affected with psoriasis and lepra.

528. *Complex or hypertrophy of organs* of a healthy kind may result from a more copious flow of blood to them, contingent on their increased use. Thus, the uterus becomes hypertrophied in pregnancy; the breasts during lactation; one kidney becomes enlarged when its fellow is incapacitated by disease. The brain is more developed in proportion to the active exercise of the mind; and when this is carried too far, if inflammation, congestion, or some other vascular disorder, do not occur, the brain may become hypertrophied, and by its bulk being too great for its bony case, it compresses the vessels, becomes indurated,

and, as an obvious consequence, its functions are more and more impaired. Thus, in young subjects who have been remarkable for precocity and activity of intellect, the brain has been over nourished, and fatuity and coma have been the result. Mucous and cutaneous follicles sometimes acquire an extraordinary development after continued excitement, or without any such obvious cause. Bursæ become enlarged in situations exposed to much pressure or friction, as on the shoulders of porters, the knees of housemaids, the elbows of miners, and the ankles of tailors.

The hypertrophy of the liver and spleen in protracted ague, may perhaps be referred to the frequent repetition and long continuance of the enormous congestions which this disease induces in these organs. I have known a similar enlargement ensue after prolonged exposure to cold and wet. But in some cases no such external cause can be traced; and the hypertrophy must be referred to a peculiar condition of the circulation of the affected organs, or to an unusual activity in their nutrient molecules. To this obscure category may be appended the case of enlargement of the thyroid gland in bronchocele.

529. The *treatment of* hypertrophy must depend on the pathological cause which induces it. In most cases, this cause is some variety of hyperæmia, and the treatment suitable for the variety is to be employed, (see Congestion, Determination of blood, and Inflammation.) But some remedies seem especially calculated to counteract the hypertrophy which these elements induce; such are iodine and its preparations, mercury, alkalies, and, in the more sthenic cases, sedatives and evacuants, together with low diet. The same remedies are occasionally useful also in hypertrophy less distinctly connected with hyperæmia, as bronchocele. In all cases it is proper to attempt, as much as possible, to remove or counteract the exciting causes of hypertrophy, as by tranquillizing the circulation in hypertrophy of the heart; by soothing irritations of the stomach, bladder, &c., in obstructive diseases of these viscera; removal from malarious districts in case of visceral enlargements, &c.

SECTION III.

DIMINISHED NUTRITION—ATROPHY.

530. Atrophy, unlike hypertrophy, (§ 525,) may be a general disease; that is, all parts of the body may waste so much as to impair their functions. *General atrophy*, *marasmus*, or *emaciation*, consists in a removal of a considerable amount of the textures by decay and absorption without a sufficient reparation by

nutrition, (§ 523.) Hence the causes of atrophy may be divided into the circumstances which promote decay, and those which prevent reparatory nutrition. Among the former may be counted excessive and prolonged exertion, want of sleep, extreme anxiety of mind, or continued suffering; under any of these, a person is familiarly said to be "worn to a shadow," without any more distinct disease taking place. But on examining the urine in such cases, it will often be found to contain an excess of urea, resulting from the decay of textures. This secretion is also sometimes alkaline, and unusually prone to decomposition, and the intestinal and cutaneous excretions sometimes exhibit an uncommon fœtor, arising from the same tendency to putrescence. A fever of a low or hectic kind may be excited as a secondary result of these changes, and this fever is mistaken for the cause of the wasting. In cases of marasmus from excessive secretions or drains from the body, there is often also proof of accelerated pecay: thus, diabetes mellitus reduces the body, not only by perverting and draining off its nourishment, (§ 255,) but also by promoting the decay of textures which is manifest in the increased amount of urea excreted.

The circumstances which impair or prevent reparatory nutrition are several, and may occur in any or all the steps of the nutritive process, from the reception of food into the system to its appropriation and assimilation to the living textures. As examples in this series may be mentioned—1. Defective quantity or innutritious quality of food; 2. Disorder of some part or parts of the digestive apparatus, such as extreme dyspepsia, diarrhœa, &c., which prevent the formation of chyle; 3. Diseased mesenteric glands or tumours obstructing the thoracic duct, intercepting the supply of chyle to the blood; 4. Perversion of the assimilating process by which chyle is converted into blood, (§ 253,) as in diabetes mellitus and chylosus; 5. Defect in the formation of fibrin, (§ 196,) and albumen (§ 221) of the blood, the materials of nutrition, so that, instead of becoming the plastic material for repairing the texture, they have a tendency either to pass into decomposition, as in malignant fevers,* (§ 257,) or to concrete in a cacoplastic or aplastic form, as in tuberculous diseases; 6. Excessive discharges of various animal fluids, of blood, pus, serum, milk, semen, mucus, &c., or morbid growths, which monopolize the nourishment of the body, such as tumours of various kinds, particularly cancer; 7. Parasitical creatures, such as hydatids, worms, &c.

* My friend, Dr. Hodgkin, considers a suspension of textural nutrition to be a chief cause of the phenomena of fever, and has very ingeniously applied this notion to explain many of the symptoms. Lectures on Morbid Anatomy of Serous and Mucous Membranes, vol. ii. p. 490.

531. A consideration of the above list of causes of emaciation will show how uncertain it is as a symptom if it be taken alone; but when traced to its cause, it is a very important index of the amount to which that cause operates on the living body. Emaciation will rarely continue or advance to an extreme degree without structural changes rendering the cause permanent; hence, extreme marasmus is generally connected with tuberculous disease, carcinoma, (especially of the stomach,) or some serious organic disease. The chief exception to this is diabetes, the intractable persistence of which is involved in much obscurity.

532. *Partial atrophy*, the reverse of partial hypertrophy, commonly arises from defective supply of blood to the part. Sometimes the defective supply is from the disuse of the part: thus the eye wastes in confirmed blindness; muscles and whole limbs become atrophied from disuse in paralysis and anchylosis: the testicle and the mamma waste with age, &c. Frequently partial atrophy in an organ succeeds the changes induced by inflammation or other structural disease; the matter effused swells some parts, compresses others of the texture, and, by preventing a due supply of blood, causes a subsequent atrophy. This is especially the case when the products of inflammation or congestion are cacoplastic, as in cirrhosis of the liver and granular disease of the kidney, in the consolidation of the lung caused by pleuropneumonia, &c.: the deposits here produced tend to contract and compress the vascular structure, and thus deprive the organ of its nourishment; it accordingly shrinks in size, or, in the case of the lungs, the texture may become thin and emphysematous. In chronic pneumonia and phthisis, also, many blood-vessels in the lung become obliterated, and the texture may either waste or further degenerate, according to its condition. Atrophy of the heart and brain have sometimes been found connected with ossification and partial obstruction of the arteries supplying them. The dwindling of limbs in children, and the lameness in old persons from shrinking of the neck of the thigh-bone, appear to depend on similar impediments in the vessels supplying the parts.

533. The *treatment of general atrophy* (§ 530) must be directed to remove or obviate the cause where that is practicable, to supply proper and adequate nourishment, and to promote the healthy action of the digestive, assimilatory, and circulatory functions. The means of fulfilling these indications, where attainable, would require too lengthened a detail to be introduced here: it must suffice to mention the chief remedies and measures to be opposed to the several pathological causes of atrophy.

Atrophy, from excessive or prolonged exertion, is to be treated by a sufficient amount of rest and nourishment; that from anxiety of mind, suffering, or sleeplessness, by various medicinal narcotics, and change of air and scene, as well as by measures calculated to soothe under the particular circumstances. The effect which opiates and other narcotics sometimes have in diminishing the urea excreted in such cases, points out that these remedies tend to control decay, and they may sometimes be aided by mineral acids and various tonics. The same remedies are useful in diabetes mellitus, the marasmus of which is however to be still further checked by withdrawing *all* articles of food that can be converted into sugar—that is, all farinaceous, amylaceous, saccharine, and gelatinous matters, (§ 256.) I have generally found the excessive discharge and the emaciation of diabetes to be effectually controlled by the full application of this rule, but never by its partial observance, as recommended by Dr. Prout.

The counteraction of the circumstances which impair or prevent reparatory nutrition (§ 530) comprise the treatment of the several diseases and causes of disease before enumerated under the seven heads, which it is not necessary to recapitulate. In most of these the use of food as nourishing as the stomach can digest, and of tonics, medicinal and hygienic, as bracing as the body can bear, with due attention to the regularity of the excretions, afford the best chance of resisting or retarding the emaciation; and their utility will much depend on the judgment with which they are applied.

534. As *partial atrophy* often arises from defective circulation in a part, it may sometimes be counteracted by measures calculated to promote the passage of blood through that part. Thus, muscles wasted by disuse are sometimes increased and strengthened by blisters, stimulant frictions, electricity, and exercise. Atrophy following inflammation or congestion may sometimes be advantageously opposed by the remedies for the results of these conditions, especially iodine in combination with tonics, as iodide of potassium and sarza, iodide of iron, &c. In this and most other cases of structural disease, although treatment can do little to remove partial atrophy already induced, yet it may sometimes retard its increase by restoring a more healthy circulation throughout the body.

PERVERTED NUTRITION.

535. Under this head are comprehended all those changes of textural nutrition that go beyond mere degrees of *plus* and *minus* in the natural molecules of the textures; they either alter the *quality* of the texture, or form new textures, growths, or deposits, in connection with the normal texture. These changes often comprise partial hypertrophy and atrophy as well; and in so far as they do so, the observations already made with regard to those

elementary changes may be extended to these, but with new additions.

SECTION IV.

INDURATION AND SOFTENING.

536. We have mentioned both *induration* and *softening* to occur as the results of inflammation; softening being commonly connected with the increased secretion and absorption occurring in acute inflammation, (§ 427;) and induration being rather a sequel of the more chronic kind, which causes a continued overflow of the solid nutritive matter, (§ 479.) Both these changes sometimes take place independently of complete inflammation; but they probably, in most cases, depend on some of its elements.

537. *Induration* is constituted by an increased deposit of solid matter in a structure, or by compression of that structure, or by both. In some cases of insanity, the inner table of the skull acquires the hardness of ivory. In newly-born children, the skin acquires an unusual hardness and rigidity, rendering them "skin-bound." Glands and other soft compound structures sometimes become hard without inflammation. Probably, in all these cases, there is prolonged determination of blood to the parts, which causes an exaggeration of the nutritive function; but the matter exuded is more hyaline, (§ 523,) or simply granular, (§ 452, 3,) than consisting of highly organized cell-germs or fibres; hence the result is not simple hypertrophy or increased growth, but a more condensed and more uniform texture. A somewhat similar change is produced in the lung by compression, by liquid effusion, or a solid tumour, especially when the lung itself is also inflamed, as in pleuro-pneumonia, in which the pressure restrains the full development of the exudation corpuscles. The induration of cartilage, &c. by osseous deposit is more properly transformation than simple induration. So induration of the liver, kidneys, and other organs, generally comprise granular deposits, and other changes of structure.

538. *Softening* arises from different causes in different textures. In some instances the cause, being peculiar to the structure, may be called specific. Thus in the bones it proceeds from defective deposition of phosphate of lime, the earthy matter which gives solidity to these structures. The softening of the stomach found after death is caused by the solvent action of the gastric juice. The softening of various textures, especially muscles, in fevers and other cachectic states, is connected with a defect of fibrin in the blood, (§ 196:) the same cause which removes this fibrin, and prevents its formation, (§ 216,) apparently dissolving or loosening

the fibrinous parts of solid textures. In other instances, softening is a variety of atrophy, arising from a defective supply of blood; so that the texture of a part decays, and is absorbed away faster than it is repaired. Thus softening of the brain and heart is sometimes found connected with ossification and partial obstruction of the arteries supplying these parts. Softening of the affected muscles sometimes accompanies paralysis, especially that from lead. In a few instances, partial sofening, like atrophy, follows inflammation, and is to be ascribed to the obstruction of vessels which that affection has produced. Thus softening of portions of the brain occasionally follows meningitis, softening of the heart succeeds to pericarditis; softening of the stomach and intestines occurs after some kinds of gastro-enteritis; softening of the articular cartilages sometimes succeeds to their inflammation.

In all cases of partial softening, although the chief cause is local, yet a nonfibrinous or aplastic condition of the blood materially assists in promoting this result; and it is a serious question whether the continuance of antiphlogistic measures and abstinence does not occasionally promote this consequence of the changes of inflammation. Some of the most distinct cases of softening of the heart and brain that I have met with, have been those in which the patients have been long kept in a reduced state for fear of return of inflammation of the heart and head.

539. Induration and softening being opposites of each other, although sometimes preceded by similar causes, require in some degree parallel modes of *treatment*, but in an opposite way. Induration, consisting of condensed hypertrophy, and often arising from prolonged determination, may be counteracted by partial antiphlogistic measures, especially those tending to remove obstructions and deposits, (§ 511, 515.) Thus mercury and iodine, externally and internally used, and alkaline saline medicines, are supposed to have some power in discussing hard swellings; and setons, issues, or suppurating counter-irritants, which draw away blood and nutriment from the indurated part, may be found in some cases useful. But extreme antiphlogistic or reducing measures are not indicated, (§ 218,) inasmuch as induration itself implies a degraded kind of the nutritive material, (§ 537,) and does not result from acute or sthenic inflammation.

540. In cases of softening that are not specific, (§ 538,) the indications of treatment are, to restore a more fibrinous or plastic state of the blood generally, and to improve the circulation in the atrophied part. In fevers and cachectic states, where the softening is general, the first is the chief indication, and some of the means of fulfilling it have been already noticed, (§ 216.) Besides nourishing food, and agents which improve the digestion and cir-

culation, tonics and stimulants are often useful. How far the operation of mineral acids, bark, and other tonics, depends on their astringent or bracing influence on the animal fibre, we cannot undertake to determine; but after fevers, and in cachectic states, they do appear to improve the substance and firmness of the solids in a way more direct than by merely exciting the circulation and ameliorating the condition of the digestive organs. So, too, the operation of stimulants, both local and general, probably goes beyond that of accelerating the circulation, and determining blood to parts where it is ill supplied: it probably also increases the production of fibrin and cell-germs from the albumen of the blood, just as we see this to result from the application of stimulants before they cause inflammation, (§ 294, 415.) The relief sometimes afforded to the symptoms of softening of the brain and heart, after all inflammation has ceased, by mild stimulants, tonics, and a moderately nourishing diet, is too little known to those who have always the dread of inflammation before their eyes, and who yet forget that a chief evil of inflammation is the injury it inflicts on function and structure, which injury often lasts when the inflammation is gone or is of trivial amount. The beneficial effect of nourishing diet and stimulant applications to soft, flabby ulcers, is another illustration in favour of this kind of treatment in cases of internal disease, where the general weakness, apyrexia, pallidity, and muscular emaciation, much preponderate over the symptoms of local irritation.

541. The treatment of the specific example of softening found in the bones is not well understood. The circumstances which promote or impede the deposition of phosphate of lime in the bones are not clearly known; but measures of a tonic kind, with appropriate nourishing diet, have been found distinctly useful in rickets in children. The mollities ossium of adults is a still more obscure and intractable affection. The formation of callus at the ends of a fractured bone, and the completion of the ossific process in it, are promoted by generous diet and tonics.

SECTION V.

TRANSFORMATION OF TEXTURES.

542. When one elementary texture, as muscle, is replaced by another, as fibro-cellular, it is said to be *transformed*. The term *degeneration* is also generally applicable to this change; for the new texture substituted for the old is most commonly lower in vital properties. The chief exceptions are in the case of skin being transformed into mucous membrane, when by anchylosis

of a joint, an external surface is brought almost to the condition of an internal; and the converse case of transformation of mucous membrane into skin, as in long prolapsed uterus. In these instances, the changes appear to arise from the physical condition in which the membrane is placed: the exudation corpuscles remaining soft and moist, and becoming epithelium scales and mucous globules in one case, and drying into epidermis in the other.

543. Muscle is sometimes transformed into fibrous or fibro-cellular texture, in some cases after inflammation of contiguous parts. This has been noticed in the heart after pericarditis and endocarditis, in the intercostal muscles after chronic pleurisy, and in some of the muscles of the limbs after prolonged rheumatism. Loss of substance in muscles from wounds or ulcers is generally replaced by a similar fibro-cellular texture, and never by new muscle.

Muscle has rarely been found degenerated into a fatty matter, the proper muscular fibre being replaced by a greasy homogeneous structure. This has been observed under circumstances similar to those attending fibrous degeneration. Something of the same kind takes place sometimes in the muscles of persons long affected with sea-scurvy. Natural fat sometimes infringes on muscles, particularly the heart; but that is by the hypertrophy of the fat-cells pressing on and causing atrophy of the muscular fibres, and not by transformation. The same abnormal growth of fat is not uncommonly met with in the pelvis and calices of the kidneys. The fibrous transformation of muscle seems to be simply the result of a degradation of the nutritive process, fibrous texture being obviously less endowed with vitality than muscle. According to Mr. Gulliver, the opaque patches in arteries called atheromatous consist of a fatty deposit. The fatty degeneration of textures is involved in more obscurity; but it may receive some illustration from the spontaneous conversion into adipocire which this and other animal substances undergo in the course of time, when kept moist, yet prevented from rapid decomposition. The considerable proportion of oil globules found in some exudation corpuscles by Gulliver, Gruby, and others, would also seem to point out that fatty matter may result from a modification of the nutritive secretion. Nay, according to the examination of Dr. Davy, exudation corpuscles (in the lungs at least) chiefly consist of margarine and olein.* But this does not accord with the account of fibrinous exudations generally given by chemists. The whole subject requires a fuller examination.

Fatty degeneration of the liver admits of easier interpretation;

* Mr. Gulliver's Notes to Dr. Boyd's "Vital Statistics," p. 53.

for, according to Mr. Bowman, the natural secernent structure of this gland contains a considerable proportion of fatty particles; and the excessive increase of these, with atrophy of the other structures, may constitute the fatty transformation.* It has been surmised that this fat is that of the bile in the process of its formation in the secreting cells; and that its increase in phthisis is due to the additional task thrown on the liver to excrete the hydro-carbon, which the lungs cannot remove. If this were true, fatty degeneration of the liver should occur more constantly in phthisis, and in other diseases of the lungs, than it does. It is met with chiefly in females, in whom emaciation has proceeded with rapidity; and I should rather ascribe it to the arrest of the fatty matter from the blood, which is taken up from the textures in their rapid decay, and of which the liver appears to be the appropriate excreting organ. It is also possible that the fatty matter which is formed in tubercle during its process of softening may be conveyed into the circulation, and contribute to the greasy degeneration of the liver.

544. The most common transformation is that of cartilage into bone. This commonly takes place as a result of age, and may be said to be rather a petrifaction than an ossification; for the proper structure of bone is wanting. The deposition of osseous matter, however, seems to follow the same rule as in true bone, in which it increases with age. So, too, morbid ossifications result from inflammation or continued determination of blood, as instanced in the ossification of the cartilages of the air-tubes in chronic laryngitis and bronchitis, of the cartilages of the ribs in chronic pleurisy, and of the inter-vertebral cartilages after injuries of the spine. Thus inflammation, or rather the determination of blood which accompanies it, hastens the process of ossification to which cartilages tend in the lapse of years.

A similar tendency to ossification (or rather petrifaction, for there is still less of the true bony structure than in the last case) is observed in cartilage, fibrocartilage, and fibrocellular texture, accidentally produced by inflammation, (§ 452,) transformation, (§ 542,) or morbid growths. Thus, osseous concretions or laminæ are formed on serous and fibrous membranes, in cellular texture, and in the accidental cartilages found in joints. This appears also to be the mode in which ossification of arteries and the valves and membranes of the heart takes place: an opaque fibrocellular deposit first occurs, and phosphate of lime afterwards concretes in plates or granules in it. The plastery and calcareous

* In the most authentic accounts of cases of spontaneous combustion of the human body, there are some particulars which seem to imply that there must have been a fatty transmutation of textures.

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transformation of tubercle is obviously allied to the same process, and by proving that it takes place in aplastic and comparatively dead matter, seems to prove that osseous deposit is a chemical rather than a vital change. The similar changes sometimes exhibited in the cartilaginous bodies loose in veins (phebolites) and in the cavities of joints equally show that the transformation is spontaneous.

545. Our knowledge of the nature and symptoms of transformations is not sufficiently definite to suggest any observations with regard to their treatment. The general fact that they are examples of degeneration or degradation of vital properties, would indicate the propriety of employing measures for supporting the vital powers generally; but inasmuch as local inflammation or determination of blood sometimes seems to hasten these changes by supplying the material, topical measures against these elements may sometimes be useful.

SECTION VI.

DEPOSITS IN OR UPON TEXTURES.

546. I apply the term *deposits* to matters which result from an overflow of the nutritive material beyond what is necessary to nourish the textures themselves. The structural lesions hitherto considered are alterations of the textures themselves; deposits are new matters added to the textures. The basis of all deposits is the fibrinous matter of the blood; and in the products of inflammation (§ 450—3) we have described its varieties in relation to its plasticity or capability of organization. The same division is applicable to deposits, which take place independently of inflammation, as results of an overflow of the material of reparatory nutrition, and thus we have *euplastic*, *cacoplastic*, and *aplastic* deposits from perverted nutrition. The history already given of these as they result from inflammation will supersede the necessity of much detail now, and it will suffice to advert to the circumstances in which they arise independently of inflammation.

Euplastic Deposits—Cicatrices.

547. When a living part is cut or wounded, the breach may be repaired by three modes:—1. By the growth of the adjoining parts, or walls, of the wound; 2. by the medium of coagulable lymph, which becomes organized and forms a cicatrix, or bond of union; and 3. by granulations and lymph together. The latter mode being necessarily attended with inflammation, is excluded

from notice here; but the other two, as Dr. Macartney has shown, may occur independently of obvious inflammation, and are more perfect without it. To these, however, a certain amount of determination of blood, which supplies the plastic material, is necessary; and premising this addition, I will quote the clear description which Dr. Carpenter has given of these reparative processes. (Principles of Human Physiology, Am. ed., p. 440.)

"The surgeon has, until recently, regarded the processes of granulation and suppuration, which are attended with much local inflammation and with a considerable amount of constitutional disturbance when the surface is large, as the only means by which an open wound can be filled up. Occasional instances, however, have not been wanting in which large open wounds have closed up under the dry clot of blood by which they were at first covered over, without any suppuration or other symptom of inflammation; and in these it has been found that the new surface much more nearly resembles the ordinary one than does the cicatrix which follows granulation. To Dr. Macartney, however, is due the merit of explaining the *rationale* of this action, which is precisely analogous to that which is concerned in the ordinary processes of growth, and to that reproduction of whole parts which takes place in the lower animals without inflammation.* It is termed by him the modelling process; and he remarks, as characteristic of it, that when it goes on perfectly and without inflammation, the patients are so completely free from uneasy sensations as only to be aware of the extent of the injury by their own examination. In this process the surfaces of the wound do not unite by vascular connection even when they lie in contact, nor is the space between them filled up with coagulable lymph; but they are smooth and red, moistened with a fluid, and presenting the appearance of one of the natural mucous membranes. "It might be anticipated that as this mode of reparation bears so strong a resemblance to the natural formation and development of parts, it is the slowest mode; but this is of little account when compared with its great advantages in being unattended with pain, inflammation, and constitutional sympathy, and leaving behind it the

* The following observation illustrates this point:—"I made a small pin-hole in a frog's web; the capillaries that were divided yielded no blood, and became obstructed; but the circulation continued, although sluggishly, in those adjoining, which were distant from the puncture the length of six or eight blood-disks. The next day, these vessels were no nearer; but the circulation in them was more active, and the hole was partly filled up; and on the third day, it was completely so, yet no moving blood could be seen nearer to it. On the fifth day, the distribution of visible vessels was not altered, but the matter with which the hole was filled had contracted and become opaque, so that the adjoining vessels were drawn nearer together, and the opacity prevented my seeing whether any passed through the cicatrix."—Gulstonian Lectures, Med. Gaz., July 30, 1841, p. 721.

best description of cicatrix." In the case of large burns on the trunk of children, the difference between the two modes of reparation will frequently be that of life and death, for it often happens that the patient sinks under the great constitutional disturbances occasioned by a large suppurating surface, although he has survived the immediate shock of the injury.

548. "The most effectual means of promotiug this kind of reparative process, and of preventing the interference of inflammation, vary according to the nature of the injury. The exclusion of air from the surface, and the regulation of the temperature, appear the two points of chief importance. By Dr. Macartney, the constant application of moisture is also insisted on.* He states that the immediate effects of injuries, especially of such as act severely on the sentient extremities of the nerves, are best abated by the action of '*steam* at a high but comfortable temperature, the influence of which is gently stimulant, and at the same time extremely soothing, [promoting determination of blood without inflammation.—C. J. B. W.] After the pain and sense of injury have passed away, the steam, at a low temperature, may be continued;' and, according to Dr. M., no local application can compete with this, when the inflammation is of an active character. For subsequently restraining this, however, so as to promote the simple reparative process, water-dressing will, he considers, answer sufficiently well, its principal object being the constant production of a moderate degree of cold, which diminishes, whilst it does not extinguish, sensibility and vascular irritation, and allows the reparative process to be carried on as in the inferior tribes of animals. The reduction of the heat in an extreme degree, as by the application of ice or iced water, is not here called for, and would be positively injurious; since it not only renders the existence of inflammation in the part impossible, but being a direct sedative to all vital actions, suspends also the process of reparation. The efficacy of water-dressing in injuries of the severest character, and in those which are likely to be attended with violent inflammation, (especially wounds of the large joints,) has now been established beyond all question, and its employment is continually becoming more general. Other plans have been proposed, however, which seem in particular cases to be equally effectual. To Dr. Greenhow, of Newcastle, for instance, it was accidentally suggested a few years since,† to cover the surface of recent burns with liquefied resinous ointment, (consolidating as it cools;) and he states that in this manner suppuration may be prevented, even where large sloughs are formed, the hollow being gradually filled up with new tissue, which is so like that which has been detroyed,

* Treatise on Inflammation, p. 178. † Med. Gaz., Oct. 13, 1838.

that no change in the surface manifests itself, and none of that contraction which ordinarily occurs, even under the best management, subsequently takes place. A plan has moreover been proposed for preventing suppuration and promoting reparation by the modelling process, which consists in the application of warm dry air to the wounded surface. The experiments made on this have not been entirely satisfactory; but they seem to show that, although the process of healing is much slower under treatment of this kind, it is attended with much less constitutional disturbance than is unavoidable under the ordinary method."

549. The other mode of reparation is that long denominated by surgeons *union by the first intention*, in which the sides of a wound heal by the organization of coagulable lymph, or more rarely of a clot of blood, which, when complete, forms a cicatrix. "This mode of union is ordinarily considered by British surgeons to be the result of an *adhesive inflammation*. In so regarding it, they conceive that they are following out the views of Hunter; but he expressly states that wounds may heal without any pain or constitutional disturbance, the re-union proceeding 'as if nothing had happened;' so that he in effect admits that reparation of this kind may take place without inflammation. It is well known that if a slight wound which is thus healing be provoked to an increased degree of inflammation, its progress is interrupted, and all the means which the surgeon employs to promote union are such as tend to prevent the accession of this state. The doctrine that the effusion of lymph for the reparation of the tissues is not to be regarded as necessarily a result of the inflammatory process is not so novel as its opponents have regarded it, since it has been maintained by many eminent observers, even from the earliest times. It is supported by the fact that coagulable lymph may be thrown out by a natural and healthy action, as in the formation of the decidua uteri, and that the surface of a wound is covered with lymph too soon after the receipt of an injury for inflammation to have set in.* The only case in which the occurrence of inflammation can be regarded as salutary, is that in which there is a deficiency of fibrin in the blood causing

* Although I admit that inflammation in its pronounced form is not essential to this reparatory process, yet I cannot allow that this statement is altogether correct. If inflammation is essentially what we have defined it, (§ 410,) an *increase of blood in a part, with the motion of that blood partly increased and partly diminished*, it may commence a few minutes after a wound has been made. When a frog's web is cut or pricked, the vessels adjoining the wound are immediately obstructed by coagulated blood; but in a few seconds, those adjoining them become enlarged, and receive an increased current, and it is this determination of blood towards vessels which are obstructed which causes an increased transudation of the plasma of the blood, (§ 419.) If this do not amount to inflammation, it differs from it only in degree.

a deficient organizability of the lymph," (or rather a deficiency of lymph itself.) "It has been seen (§ 438) that the amount of fibrin is rapidly increased by inflammation; and the surgeon well knows that a wound with pale flabby edges, in a depressed state of the system, will not heal until some degree of inflammation has commenced.

550. "When the liquor sanguinis, known as coagulable lymph, is effused between the two edges of a wound, or upon the surface of a membrane lining a closed sac, the following appears to be the history of its organization. The new matter which is poured out in a fluid state undergoes a coagulation resembling that of the blood; the serum, being set free by the concretion of the fibrin, is absorbed; and the fibrinous coagulum speedily attains an almost membranous density. If examined with a microscope at the commencement of the process of organization, it is seen to contain a large number of the exudation corpuscles, (§ 424;) these originating, probably, either in the lymph globules that have circulated in the blood, or in the nuclei of the red corpuscles. In a short time these corpuscles present the appearance of regular cells disposed in layers, and adhering together by an intermediate unorganized substance, bearing in fact, a strong resemblance to the cells of tesselated epithelium. Some hours later,* the mass exhibits an evidently fibrous character; and this is due (?) to the adhesion of the cells to each other in lines, their form being prolonged in the same direction. Between these cellular fibres a considerable amount of the cytoblastema or hyaline substance (§ 523) yet remains, and they may be readily separated or torn in any direction. A vascular rete next makes its appearance, and forms connections with the vessels of the subjacent surface; the first appearance of this network is in the form of transparent arborescent streaks, which push out extensions on all sides; these encounter one another, and form a complete series of capillary reticulations, the distribution of which very nearly resembles that which has been seen in the villi of the intestines. Before the vascular rete appears, pale-coloured cytoblasts are produced, which, after the completion of the rete, pass over into the nearest capillary veins, being pushed on by the blood which is brought from the nearest arteries, (§ 451;) and in this manner the circulation is established. This process appears to be conformable in all essential particulars with that which has been observed in the development of the toes of the larva of the waternewt and similar growths. The character, whether arterial or venous, which each

* In this description, Dr. Carpenter seems to have chiefly followed the account of Gerber: but Messrs. Addison and Gulliver have shown that the formation of fibres takes place at first, and constitutes the chief part of the coagulation of the fibrin.

tube is to assume, depends upon its proximity with some vessel of the subjacent membrane, with which it becomes continuous; but its first formation is not due, as some have supposed, to the simple prolongation of these vessels into the fibrinous mass, since the latter is able of itself to originate a capillary plexus."

551. Under some circumstances the fibrin of coagulable blood has been found to become vascular, and more or less organized. Thus, clots of blood in the blood-vessels have been injected, and those effused in the brain in apoplexy have been found pervaded with vessels, (Cruveilhier;) but the colouring matter does not appear to assist in the process: in fact, blood coagulated in or upon a wound generally comes off in a scab as soon as the wound is healed. In other instances, the presence of colouring matter seems to retard or degrade rather than assist the plastic process, (§ 454.)

552. The *remedial measures* by which the euplastic process is promoted in cases of injury are treated of in surgical works. Their object is to promote such an amount of determination of blood, (whether this be called inflammation or not,) and such a plastic condition of the blood, as shall contribute to the effusion of a sufficient amount of healthy organizable lymph. Where inflammation rises too high, it causes too much effusion of the plasma, which degenerates into aplastic pus globules, and it destroys the adjoining textures: here it must be repressed by antiphlogistic measures. If the inflammation is too low, (§ 477,) or the determination of blood is wanting, then the plasma will be defective in quantity or organizability, and the wound will not heal, or will heal imperfectly. Here stimulant applications may be useful. Where the blood is too abundant in fibrin, the plasma thrown out will be too copious to admit of organization, and will consequently become purulent, and therefore aplastic. Here, blood-letting or evacuants, and low diet for a time, may be serviceable. Where the blood is deficient in fibrin, the wound will be flabby and the discharge ichorous or sanious, from want of the proper plasma: here, nourishing diet, tonics, and even stimulants, general and local, may be useful. Where the wound exhibits congestion more than determination of blood, and the plasma is organized into loose spongy or fungous masses projecting from the wound, astringent and stimulant applications are beneficial.

Cacoplastic and aplastic deposits.

553. Under various circumstances which have been alluded to in the preceding remarks, wounds or ulcers may be repaired by lymph which is *cacoplastic* or defective in organizability; and the cicatrix resulting from such imperfect reparation is lower in the

scale of vitality than the texture in which it is produced. Thus in the skin, a tough, hard, fibro-cellular structure, constitutes the cicatrix; the seams formed on the healing of scrofulous sores sometimes exhibit this character; the blood not supplying a good plastic material. Or sometimes the cause of the degraded organization seems to be in the nature of the wound, or in a modification of the vessels of the part, or of their exudation, as in the scars which result from burns and scalds, and from some poisoned wounds. In these cases, the cicatrix is dense and thick; and tends further to contraction, which causes a puckering of the parts, and sometimes great distortion of the integuments. Similar deposits have been noticed to result from chronic and scrofulous inflammation of internal parts, (§ 479, 485,) and from congestion, (§ 311,) and to constitute the material of dense fibro-cellular and fibro-cartilaginous formations on and under serous and in cellular membranes; the indurated interstitial structure which characterizes cirrhosis,* and granular degeneration of the liver and kidneys, and old cicatrices and consolidations very commonly met with in the lungs. The opaque, tough thickening of the valves of the heart, often attended with corrugation, contraction, and rupture, and the similar change in the coats of arteries, appear to belong to the same class of deposits.

554. The structure of these deposits deserves to be more fully investigated. They appear to possess some organization, being composed of irregular cells and fibres, with more or less granular or amorphous solid matter to complete their substance, (§ 424.) They, however, exhibit various degrees of organization, some being vascular, and some not; but they are all inferior to the structure with which they are connected, and to the euplastic deposits above described. Although rarely occurring in great abundance in an organ or structure, except from some hyperæmia of that part, yet, in a small extent, cacoplastic deposits are to be met with in most subjects at all advanced in life, and more particularly those who have long suffered from ill health. The opaque thickening of the membranes investing the liver, spleen, lungs, heart, and brain, often arborescent from its accompanying the course of the blood-vessels—the coarser and less regular granular appearance exhibited in parts of the liver and kidneys, especially at their most depending portions, the granules commonly adhering to the capsule of the viscus when it is torn off—

* The term cirrhosis (from an obsolete Greek word, κιῤῥος, *yellow*) was first applied by Laennec to the granular degeneration of the liver; because the deposit is commonly yellow from being stained with bile. The term is obviously inapplicable to contractile deposits in the lungs and other parts; to which, nevertheless, the name has been applied. The epithets, granular or contractile deposit, are respectively more suitable to the forms in which this cacoplastic product manifests itself.

the partial consolidations of the lungs, particularly near their apex—the opaque patches in the lining membrane of the heart and arteries,—are all specimens of the result of cacoplastic deposits which age or disease has produced; and the more the nutrient function has been degraded in the individual, the more abundant will be the specimens of this cacoplastic deposit. But generally this deposit takes place more abundantly in one particular organ, in consequence of disease predisposing it to suffer, (§ 31, 2.) Thus if a person, from habits of intemperance or other cause, has injured the function or structure of the liver or kidneys, in the lapse of time, as the nutritive function begins to fail from age or debility, the injured organ is the first to suffer, and becomes the subject of cirrhosis or granular degeneration; and this may destroy life by arresting excretion, &c. (§ 170, 311) before other organs are much affected.

555. But there is another more general form of cacoplastic deposit, which takes place, when textural nutrition is degraded still further than in the preceding examples; this is in *semi-transparent, miliary, gray, and tough yellow forms of tubercle.* Instead of (with Laennec) classing tubercle under the vague term of "accidental productions," or (with Carswell) as a "secretion *sui generis,*" I have for many years referred tubercle to a degraded condition of the nutritive material from which old textures are renewed, and new ones formed; and have held, that it differs from fibrin or coagulable lymph, not in *kind*, but in *degree*, of vitality and capacity of organization.* These views have received almost demonstrative confirmation in the microscopic researches of Mr. Gulliver and others, which have detected in tubercle the materials of lymph, but in a degenerated and confused state, the cells being few, irregular, shrivelled, with imperfect nuclei, and incapable of further development; no fibres being perceptible, and the main substance being composed of granular or amorphous matter.† Every gradation may be found between

* A somewhat similar opinion, but less definitely expressed, has been entertertained by Dr. Alison, and formerly by M. Andral; but these pathologists seem originally to have regarded tubercle chiefly as the product of a modified inflammation.

† "Corpuscles more or less globular or oval are seen in tubercles; but the granular matter preponderates as the tubercular mass increases. Cells may be recognized in the miliary tubercles; but as they increase in size, the well-marked and complete cells disappear. Tubercles appear to differ essentially from the plastic exudations, inasmuch as the cells of the latter not only grow into a higher organization, but increase in number towards the centre; in other words, plastic matter has an inherent power of multiplying and evolving organic germs. But tubercle has no such power; for it would appear that its primitive cells can only retrogade and degenerate." (*Gulliver's Appendix to Gerber's General Anatomy*, p. 87.)—"If a tubercle, or even the tissue of the lung near it, be slightly compressed between two slips of glass with a drop of water, it will crumble down

euplastic and aplastic deposits; the cells and fibres which are the representatives of organization diminishing in number and completeness, and the material becoming more granular or amorphous, in proportion as the deposit is degraded, until, in opaque, crude, or yellow tubercle, it is altogether aplastic, consisting of a mere aggregation of granules, with mere traces of the remains of cells.

I consider that the more solid forms of tubercle are entitled to a place among cacoplastic deposits; because, although destitute of vascularity, they seem to possess a kind of structure, like that of the lower kinds of fibro-cartilage and granular deposit. Their affinity with granular degeneration is shown by their commonly occurring in the same subjects, and by their frequently exhibiting the same tendency to contraction. In a very large majority of cases of chronic granular degeneration of the kidneys or liver, there are found more or less traces of tubercle in the lung, its chief seat; and in very few instances of chronic phthisis have I failed to find some degree of granular disease in the liver or kidneys. In acute phthisis and acute granular disease, local causes accelerate the degenerative change to a destructive extent in one organ, before there is time for others to become affected.

556. Let us now trace the history of cacoplastic deposits in a few examples. The dense false membranes on the surface of serous membranes may be often seen surrounded by a radiated wrinkling or puckering of the adjoining parts, indicating that

and break to pieces, the fluid being at the same time quite white or milky. This white appearance is attributable to a great number of minute objects, the assemblage of which constitutes the substance of the tubercles. They consist for the most part of molecules, granules, and granulated corpuscles, of various sizes, of aggregated granules without any tunic, and of collapsed tunics without any granules. These objects are mingled with a great many shapeless flakes and filaments, which are no doubt fragments of the membrane of the air-cells, and of the minute blood-vessels, which, when involved in a tubercle, become so extremely brittle, that they must necessarily form a considerable proportion of the objects occupying the field of the microscope. The granulated corpuscles of a tubercle are sometimes very large, ($\frac{1}{800}$ or $\frac{1}{1000}$ of an inch; and the molecules and granules, which are very conspicuous, may frequently be seen on the point of escaping from them....... The semi-transparent forms of tubercle and tubercular infiltrations owe their peculiarity to a great relative amount of granulated vesicles, (*cells*, Gulliver,) whereas the opaque white forms of tubercle are attributable to great numbers of isolated granules."—*Mr. Addison's "Experimental and Practical Researches, &c.;" Trans. Provincial Med. and Surg. Association*, 1843, p. 287, 8.

These quotations supply microscopic evidence in favour of views regarding the nature of tubercle, which I have long held and taught, and to which I was led by an attentive examination of the common characters and changes of lymph, pus, and tubercle. A brief notice of these views may be found in the four editions of my little work on the "Pathology and Diagnosis of Diseases of the Chest;" in my "Lectures on Diseases of the Chest," published in the "Medical Gazette" of 1837, 8; and in the "Library of Practical Medicine," vol. iii. 1840. All these works were published long before any of the above microscopical examinations were made.

the new depost has shrunk in size. A similar contraction is noticed in the deposits on and under the lining membrane of the heart and its valves, and causes a serious disturbance of their mechanism. The contraction of the chest in some cases of pleurisy is, in part, dependent on the same property of cacoplastic deposits. This general tendency of certain false membranes to contract was, I believe, first distinctly pointed out by Dr. Hodgkin; and the fact has been applied by Dr. Carswell to explain the contraction of the liver in cirrhosis, which he considers to depend on a deposit in the intravascular cellular texture prolonged from the capsule of Glisson. I do not consider that the contractile deposit in cirrhosis is exclusively confined to any texture. False membranes, which exhibit the same contractile property, are sometimes found on the free surface of serous membranes, and especially along the course of the vessels, (veins as well as arteries;) and on the liver and lung, depressions from atrophy of the substance of the organs are sometimes seen under these deposits. There can be little doubt that these deposits are merely exuded from the vessels in certain pathological states, (congestion, chronic inflammation, and malnutrition,) and form a dense structure of low vitality, which, by its subsequent contraction, tends to constrict and compress the subjacent parts, and more or less to interfere with the passage of blood through them, and consequently with their secretion and nutrition. The same tendency is shown in the higher (less aplastic) forms of tuberculous disease. Miliary or granular tubercles in the lungs, when in considerable numbers, and not soon softening, cause a contraction of the lung, chiefly at the upper part, and a corresponding collapse in the upper part of the chest. I have met with many cases, in which a sinking in of the infraclavian region took place before any symptoms of softening or excavation had occurred; indeed, it is a very common sign of tubercles which long remain stationary. The still greater amount of collapse, in the advanced stages of tuberculous lesions, although partly dependent on other causes, is also in some degree connected with the contraction of cacoplastic deposits in the lungs and pleura. In the peritoneum, agglutinated tubercles often cause considerable contraction; and I have seen the omentum thus puckered up into a knotty mass.

It would be an interesting point to compare the microscopic structure of cacoplastic deposits before and after their contraction. It is most probably that it is by the partial absorption of the granular or amorphous portion of the deposit, and by the closer approximation of the cells or more organized constituent, that the condensation takes place. Hence, it may be, that the structure so contracted is less liable to the further degeneration to which cacoplastic deposits commonly tend. Certain it is, that of different portions of cacoplastic deposit in the lungs and elsewhere, those that are contracted remain unchanged, whilst others pass into the aplastic state of opaque and softened tubercle. This contractile process seems, therefore, to raise the deposit to a higher standard, in which, although below them, it is tolerated by the adjoining textures. But this very change may seriously injure them, by contracting and compressing their vessels, and interfering with their nutrition and other functions. This is the chief mode in which the granular diseases of the liver and kidneys gradually infringe on the circulation and secretion of these organs, and thus may eventually prove fatal, (§ 249, 375.) The contraction which takes place near the summits and roots of the lungs, in the more limited and therefore chronic forms of pulmonary tuberculous disease, often lay the foundation of emphysema of the lungs and habitual asthma. I have notes of a large number of cases illustrative of this fact; but such details belong to special pathology, and are reserved for another work.

557. Having adverted to the less degraded or degenerating form of cacoplastic deposits, we have now to notice those of a lower character, which tend to become aplastic. These include the commoner forms of tubercle. In the granular, miliary, gray, or drab-coloured tubercles of serous membranes and parenchymata, we find a dense homogeneous solid, closely resembling some of the other cacoplastic deposits which have just been described. Their resemblance, and even identity, may often be well traced in chronic or subacute arachnitis, peritonitis, and pleuritis, in which portions of the affected membrane are covered with diffused patches of semi-opaque deposit, which no one would hesitate to call false membrane; whilst in other parts the same deposit, occurring in separate granules, exhibits all the characters of granular or miliary tubercle. But how comes it (may be asked) to assume the granular form? In answer to this question, I may refer to the observation made on the products of inflammation, (§ 449,) where it was pointed out, that the effusion of lymph on an inflamed membrane is at first granular, and would continue to be so, if it were not drawn or spread into threads or films by the friction or pressure of the surfaces where it is poured out; and several examples were cited, in which, from the absence of such friction or pressure, the granular appearance is preserved even in acute inflammation. In chronic inflammation, in which the matter effused is from the first less ductile and more consistent, the granular condition more generally remains; and it is generally admitted, that the product of chronic inflammation of the peritoneum and arachnoid is always more or less granular.

But tubercles do not always result from inflammation. In many cases, they are found disseminated in so many textures, after few or no symptoms of inflammation, that it is impossible to regard them otherwise than as the result of modified textural nutrition. The cell-germs by which the material of textures is renewed, are imperfect at particular points; the granular or hyaline matter abounds and concretes without fibres or vessels being developed; at this point a hard granulation appears. Where a granule has once been formed, it becomes a nucleus for the concretion of more: a new habit or mode of nourishment is established at the spot; or, to speak less figuratively, cacoplastic matter (if present in the blood) concretes around it by a process similar to that by which fat attracts fat, or bone, osseous matter; perhaps the process is not wholly unlike that of crystallization. But however it happens, the result is, that the granular tubercle grows, and may attain the size of a millet-seed, hemp-seed, or even a small cherry-stone; or, being subjected to pressure, may somewhat spread or flatten into various shapes.

558. But tubercles rarely grow much without exhibiting another change in their appearance. They lose their semi-transparency, and become of an opaque or dead, pale, yellow hue, like the colour of raw potato or parsnip. This is the transformation to crude yellow tubercle first described by Laennec. This change is the result of a further degradation of the deposit. The few cells which are to be detected in gray tubercle become indistinct, and the mass is merely granular, and therefore quite *aplastic*. Generally the change begins in the centre of the mass, apparently because, being devoid of vessels, the centre is further removed from the vivifying influence of the blood. Yet congestion or inflammation in the neighbourhood seems to accelerate this change just as they hasten the conversion of lymph into pus, the plastic into the aplastic, by the increased warmth and afflux of fluids promoting the degenerative change—the loss of vitality—to which tuberculous deposits tend.

559. But tubercle is frequently deposited at first in this yellow, opaque state, this circumstance being a mark of the still more degraded condition of the nutritive function; and the more extensive forms of tuberculous disease commonly abound in this aplastic matter. Thus in rapid phthisis, whether resulting from acute inflammation or from the prevalence of scrofulous (cacoplastic) diathesis, yellow tubercle commonly forms a large portion of the deposit; and it is in these cases that its resemblance to, and connection with, coagulable lymph may be best seen.* Yellow

* The affinity between lymph and tubercle was recognized by older writers; but after it had been kept out of view by the too exclusive opinions of Bayle and Laennec, it was again fully pointed out by Dr. Alison. (Trans. of Medico-Chirurg. Soc. of Edin., vols. i. and iii.)

tubercle is rarely so hard or so tough as the gray or semi-transparent kind; and in the cases of rapid deposit just mentioned, it is often much softer and more friable. Now, this is the commencement of a change to which the lowest forms of tubercle tend—that of *maturation* and *softening* into a cheesy substance. The conversion of the gray into opaque tubercle, and the further softening of this, seem to be the converse of the contractile process to which the higher class of cacoplastic deposits tend: in that, (the contractile process,) the deposit becomes more dense and organized: in this, (opaque change and softening,) the deposit becomes less dense, and loses the little trace of structure which it had: it degenerates into an amorphous, granular mass; and being lifeless, it is no longer nourished; but its granules lose their cohesion, and become disintegrated by the chemical action of the adjoining fluids.* Mr. Gulliver has also observed an appearance of fat globules into softened tubercle. The formation of these in old pus, (§ 460,) in atheroma of arteries, and in gangrene of the lungs, seems to show that fat is sometimes a debris of animal matter, as in the conversion of flesh into adipocire, (§ 543.) The lenticular corpuscles concentrically striated, supposed by Gruby to be characteristic of softened tubercle, Mr. Gulliver has found, in various textures, unconnected with tubercle or any other disease. The detection, by Dr. Davy, of oleine and margarine in opaque exudation corpuscles, (§ 543,) shows a tendency to the production of fat in all degenerated plasma.

560. But in these different changes in tuberculous matter, as well as in the original deposition of this matter, the adjacent living parts have a considerable share. A miliary tubercle from its first formation may become a cause of irritation and obstruction to the contiguous textures. The amount of this irritation and obstruction will depend on the natural or present vascularity and excitability of the part, its function, and the situation and size of the tuberculous deposit. Thus, in vascular textures, especially parenchymata, there is more tendency to mischief and change than in serous membranes. Where the irritation is very slight, it may merely cause so much determination of blood as to promote the growth of the gray tubercle. Where it is more, it may cause the conversion of gray into yellow tubercle, its further increase in

* Dr. Elliotson, I think, first suggested that the softening of tubercles is due to a spontaneous chemical change. I also consider the change to be chemical; but to arise from the action of fluids from adjoining parts. So long as tubercles are kept free from superfluous moisture, they manifest little disposition to change; but an afflux of fluids around them hastens their maturation and softening. This effect may be rudely illustrated by the action of water or serum on coagulated albumen. When nearly dry, it is tough and semi-transparent; but when well moistened, it becomes opaque, soft, and friable. The softening of clots of fibrin by warmth and moisture gives another illustration of the same change.

this form, and its softening. If the irritation be still greater, inflammation is excited around the tubercle; and the products of this inflammation (pus, lymph, mucus, serum, &c.) may also hasten the softening of the tubercle, their mixture together, and their evacuation by ulceration into adjoining open surfaces. Or, the product of inflammation being more solid and plastic, consolidations, or false membranes, are formed around the tubercle, and its irritating influence may be thus reduced. And although we have just mentioned that the opacity, maturation, and softening of tubercle, depend essentially on a further degeneration and loss of structure, yet these changes are much promoted by the afflux of blood to the neighbouring parts.

561. In the absence of any of the circumstances just mentioned, which tend to promote the increase or further change of tubercle, we find that it may remain harmless for months, and even for years; but then it often exhibits the transformations which may be considered spontaneous. The change of the less cacoplastic deposits by contraction has been already noticed, (§ 556.) In the lungs, the consolidations may remain long without any contraction, but they become deeply blackened by an accumulation of the peculiar black matter of the lung. Yellow and softened tubercle, if not evacuated in time, become replaced by a plastery, or putty-like matter, composed chiefly of phosphate of lime, and often containing solid concretions, consisting entirely of that earthy matter. This petrifactive change reminds us of what takes place in the cacoplastic deposits in the coats of arteries and on serous membranes, (§ 544, 553,) constituting what is erroneously called ossification. The calcareous conversion of tubercle can be explained only on the supposition that the animal matter is absorbed, and the earthy matter is deposited in its place. This is exactly like what takes place in true petrifaction of organized bodies, the silica or calcareous substance being substituted molecule for molecule: so that, when all is converted into stone, the shape of the organized body is retained. But we further learn from this that the animal matter of tubercle may be absorbed. This occasional absorption of tuberculous matter is further proved by its accumulation in the bronchial and mesenteric glands, which sometimes contain it when the lungs and the intestines contain little more than traces of it, such as cicatrices, with some cretaceous matter in them. In the bronchial glands, too, the tubercle very commonly exhibits the petrifactive change, and the concretions so commonly found in these glands may generally be ascribed to this cause.

562. The circumstances which degrade the material of nutrition, and lead to the deposition of cacoplastic and aplastic matter, may be either local or general. Of the local causes, congestion

and the lowest and more chronic forms of inflammation have been mentioned as capable of determining cacoplastic deposits; but even in these cases it is probable that the general cause also more or less operates—that is, a degraded state of the plasma of the blood. Congestions and chronic inflammations certainly cause cacoplastic effusions; but then, such congestions and chronic inflammations do not easily occur in healthy subjects; and the want of health may imply that the plasma of the blood is bad in addition to the local cause. But practically, it is of great importance to keep in view the local as well as the general cause, for the former is often more tractable than the other, and it is by guarding against it that slighter degrees of the general cause (diseased plasma) may be prevented from doing mischief. But the general cause, when present in great degree, leads to cacoplastic and aplastic deposits, as modifications of ordinary textural nutrition, independently of inflammation or even congestion. This general cause thus prevailing constitutes the chief element of the scrofulous diathesis or tuberculous cachexia, and we have before mentioned that a defect of the red particles and an excess of fibrin in the blood constitute its most remarkable feature, (§ 185, 211.) In this condition of the blood there is an increased disposition to deposit, and often an abundance of the fibrinous or nutritive material, but an imperfect vitality or organizability of this material, so that when deposited, instead of being assimilated to the textures, it forms the degenerated structures or mere granular or amorphous deposits, which we have been describing. But with this condition of the blood, these deposits must be greatly promoted by all varities of hyperæmia, and prevail most in organs which receive the largest amount of blood. Hence, the peculiarly pernicious effect of inflammation of internal organs, especially the lungs, in scrofulous subjects. Even acute inflammation may be unequal to raise the nutritive material to a plastic standard at which it may be organized or absorbed, or to mature it to the process of complete suppuration by which it may be speedily excreted; but the matter thrown out is cacoplastic, or curdy lymph, or a caseous kind of pus, inorganizable, inert, irremovable by absorption, and permanently obstructing or compressing the structures in which it accumulates, until it gradually excites an irregular destructive suppuration or ulceration, forming vomicæ, or imperfect abscesses pervading the structures, and without walls capable of healing, whilst the body wastes with hectic fever, night-sweats, and colliquative diarrhœa. So likewise fevers, by causing congestions in organs, lead to the production of a *crop* of these deposits, from which tuberculous disease takes its origin.

563. The lungs and bronchial glands are by far the most common seat of tubercles; when found elsewhere, tubercles commonly

abound more, and are more advanced in these parts. The situation of the prevalence of tuberculous disease varies also with the age of the subject. Thus, M. Papavoine found yellow tubercle in children to occur especially in the cervical and mesenteric glands; next, in the spleen, pleura, liver, and small intestines; less frequently, in the large intestines and peritoneum; and more rarely in other parts. In 350 consumptive cases examined by M. Louis, tubercles were found in the small intestines in one-third of the whole; in the mesenteric glands, in one-fourth; in the large intestines, in a ninth; in the cervical glands, in a tenth; in the lumbar glands, in a twelfth; in the spleen, in a fourteenth of all the cases; and in other parts, in smaller proportions.

The greater liability of the lungs to tuberculous deposits, has been lately ascribed by Dr. Campbell and others to the finer size of their capillary vessels, which causes them to act as filters to the blood, arresting the tuberculous matter which is supposed to become solid in the blood itself. But this view is untenable for several reasons. 1. If the fine size of capillaries were the chief cause of the deposit, it should take place abundantly in muscle, the capillaries of which are even finer than those of the lungs. 2. If the cause of the first deposit were a solid matter obstructing a vessel, the appearance of vascular distension and obstruction would be obvious in the earliest formation of tubercles, and the deposit would exhibit somewhat of a capilliform shape, which is not the case. 3. The deposit has been distinctly traced by Messrs. Gulliver and Addison to be extra-vascular, sometimes on the surface of the air-cells, and sometimes in or under the membrane composing them. I think it highly probable that tuberculous matter may form within the blood-vessels themselves; and I have repeatedly found something presenting all the external characters of yellow tubercle in the blood-vessels of tuberculous lungs. In fact, wherever fibrin may coagulate, there its degraded form, tubercle, may occur; and I cannot but refer to the case of opaque softening of clots of fibrin in coagula in the heart and great blood-vessels as bearing on this point. Formerly, this softened fibrin was mistaken for pus; Mr. Gulliver pointed out this error by showing that it had no pus globules. But its aspect and microscopic composition differ in no essential particular from those of soft tubercle, and the views which I have given would identify them in nature. This leads me to infer that the fibrin of blood stagnant within vessels, or extravasated from them, in tuberculous subjects, may sometimes change into aplastic tubercle. But the reasons before stated make it obvious that the early forms of tubercle are extravascular deposits, resulting from modifications of the ordinary nutritive secretion.

I believe that several circumstances contribute to render the lungs especially liable to tuberculous deposit. 1. Their great vascularity and the large quantity of blood that passes through them. 2. Their being a chief seat of the formation of fibrin, that principle being more abundant in arterial than in venous blood, (§ 194.) 3. The softness and yielding nature of their texture, which permits effusion to take place more readily than denser textures do. 4. Their exposure to external causes of disease, whether by cold and irritations directly entering by the air-tubes, or by circumstances operating through the medium of the circulation. In hot climates, cacoplastic diseases affect the liver and other abdominal viscera more than the lungs; the same persons there suffering from liver disease and dysentery, who, in a cold climate, would fall victims to phthisis.

564. As we have found (§ 562) that the cacoplastic condition of the blood of tuberculous or scrofulous subjects comprises a diminution of the red particles and a preponderance of fibrin, so we can state that the causes which develop this condition, and therefore induce tuberculous disease, are such as intelligibly induce one or both of these changes. Insufficient food, want of pure dry air, of warmth, and of light, long-continued mental depression, aggravated and prolonged disease of the digestive organs, insufficient excretion, (§ 249,) and the injurious influence of fevers and other serious diseases, are acknowledged causes of tuberculous disease, and may be considered to operate in both ways. Excessive evacuations of blood, or of the more animalized secretions, and severe courses of mercury, also predispose to phthisis, and may perhaps act chiefly by reducing the red particles of the blood. The cessation of growth, the termination of pregnancy, the stoppage of habitual discharges, especially purulent, and the amputation of a limb, all of which circumstances are known to favour the development of tubercle, may be supposed to operate chiefly by increasing the proportion of fibrin in the blood, when there is not a sufficiency of red particles, and of vital power, which is represented by them, (§ 183,) to give to this fibrin a due amount of vitality.

565. The *treatment* of cacoplastic and aplastic deposits, and of the conditions which lead to them, involves a vast number of details, according to their kind, situation, extent, and other circumstances in which they occur. It is not consistent with the limits of this work to enter into these details; but it is hoped that a rational view of the principles on which these deposits are to be prevented and treated may be deduced from the foregoing account. This view will comprehend those measures which have the best sanction of experience.

The elements of disease chiefly to be kept in view in the treatment are:—1. *the disordered condition of the blood, and its causes; 2. the disordered distribution of the blood, and its causes; and 3. the presence of the deposit, and its effects and changes.* The second element comprehends the varieties of local hyperæmia, which we have found to be so much concerned in producing the higher kinds of cacoplastic deposit, (§ 553,) and in promoting the formation and changes of those of a lower character, (§ 560.) Hence, the remedies against inflammation, determination of blood, and congestion, are frequently more or less needed in the prevention and treatment of cacoplastic and aplastic deposits. But, except as preventives, the utility of this class of remedies is generally limited to those of a topical kind, such as local blood-letting, counter-irritants, revulsives, derivants, and alteratives, (§ 174.)

566. The more constant and important element to be considered, in the treatment of cacoplastic and aplastic diseases, is the first named—the diseased condition of the blood; and this more demands attention, the more general and the more degraded are the deposits. The first point to be attempted is the removal or counteraction of the several causes before enumerated, (§ 564,) as contributing to induce the diseased condition of the blood. Thus a sufficient supply of food of a nutritive quality—free access of pure dry air and light, while the warmth of the body, particularly of the surface and extremities, is carefully secured—the removal or counteraction (so far as is possible) of diseases impairing digestion and excretion, and of depressing mental or bodily influences,—are among the first objects to be aimed at in treating cacoplastic diseases. Where excessive losses of blood or other evacuations have contributed to lower the plastic process of nutrition, a generous animal diet, and tonics, especially those containing iron, are especially indicated. Where the altered condition of the blood can be traced to an excess of ill-developed fibrin accumulating after the cessation of growth, the termination of pregnancy, the amputation of a limb, or the sudden stoppage of an habitual purulent or other discharge—means to eliminate the superfluous matter from the blood, either by increasing the natural secretions, or by establishing an artificial drain by blisters, setons, issues, suppurating counter-irritants, &c., are distinctly indicated; whilst tonic and invigorating measures may be also useful to raise the plasticity of the blood to a higher standard.

The foregoing measures may be considered rather as preventive than curative; but in so far as they may succeed in arresting the growth of deposits already formed, and in improving the nutritive function in general, they will favour the limitation of the deposits, and their gradual absorption or quiescence in contraction (§ 556) or calcareous transformation, (§ 561.)

567. The third object to be regarded in the treatment is the deposit that is already formed. In this case, as in most others of diseased structure, medicine can do but little. Unlike the euplastic products of inflammation, and, in some instances, unlike a simply overgrown texture or organ, the changes of absorption scarcely reach unorganized matter; and it is doubtful whether any remedy that we can use will materially promote its removal, unless, perhaps, by the simultaneous destruction of the texture which contains the deposit. Mercury has seemed to me to hasten the softening and evacuation of pulmonary tubercles; but this is by a work of destruction, and its influence on the blood has been already mentioned to be injurious. Drs. Graves, Stokes, and others, have, however, recommended mercury in the earliest stage of tuberculous disease. My own experience would lead me to avoid the specific influence of mercury in all cases of mere tubercle; but I have given it with advantage in cases of subacute and chronic inflammation simulating tuberculous disease, and even where tubercle probably existed in a limited extent. Whether mercury is of any use in granular disease of the liver and kidney, is also a subject of doubt. Alkalies and their carbonates, and iodide of potassium, have better claims to notice, although their power to dissolve cacoplastic and aplastic deposits is very uncertain.* The occasional subsidence of external scrofulous tumours under their use is the best argument in their favour; and they have this advantage, that when judiciously administered, they do not injure the blood or the constitution. They act best, and are longer borne, when combined with fluid extract of sarsaparilla and tincture of hop, or some other narcotic; and I have found this combination more useful than any other in the early stages of tuberculous disease, where there is no fever, active inflammation, or tendency to hæmorrhage. Whether the iodine and alkali ever directly promote the solution or absorption of tuberculous matter, I am still in doubt; but the signs of the presence of limited tubercles have, in many instances, diminished during their use, and the patients have regained colour, flesh, and strength. Other combinations of iodine, particularly with iron, have been recommended in scrofulous disease. The iodide of iron, and other preparations of this metal, I have found very beneficial in cases of anæmia or general weakness without much fever or local inflammation; but I have seen no reason to suppose that they promote

* The discovery of a considerable amount of a fatty constituent in cacoplastic and aplastic deposits (§ 559, 479) again suggests the idea that alkalies may act chemically by saponifying and dissolving this fat. A similar notion seems to have led Dr. Hastings to use naphtha in the early stage of tuberculous consumption; and he gives a glowing report of its efficacy. I have not given this medicine a trial sufficient to enable me to judge of its utility.

the removal of tubercles already formed. The same may be said of bark and quinine, which are, however, sometimes very useful in reducing hectic fever, when it assumes an intermittent form.

568. During the ulterior degeneration of cacoplastic deposits into yellow and caseous tubercle, there are generally symptoms of increased weakness and deterioration of the blood, with more rapid emaciation, profuse night sweats, &c. At this period, mineral acids are sometimes useful, particularly the nitric and nitromuriatic, which may be given with sarsaparilla or stronger tonics, if they are borne; and a more supporting diet, if the appetite and digestive powers will admit of it.

We know nothing of means to directly favour the quiescence of cacoplastic deposits by contraction, and of aplastic matter by petrifaction. Can the chloride of calcium, which was formerly an esteemed remedy in scrofula, in any way contribute to the latter change?

Although I have dwelt somewhat longer on the measures connected with the third indication, (to remove or influence deposits already formed,) because they are more peculiar, I again repeat, that these are less efficacious, and more doubtful in their operation, than those adverted to—but not detailed—to fulfil the first two indications, (to improve the condition of the blood, and to equalize its distribution;) the judicious application of these constitute the most important points in the prevention and treatment of cacoplastic and aplastic deposits.

MORBID GROWTHS.

569. Under the term *morbid growths*, may be arranged certain structures developed in the animal body *in addition to* the natural textures. They differ from hypertrophy and euplastic deposits in the peculiarity of their structure; and from cacoplastic and aplastic deposits, in their possessing a higher degree of organization. In other words, they differ from hypertrophy and euplastic formations in their *kind* of vitality; and from degenerations and cacoplastic deposits, in their *degree* of vitality. They are, in fact, new structures; and although some of them in general characters, and most of them in elementary composition, resemble some of the natural textures of the body; and although all derive their nourishment from the blood; yet, in their origin and growth, they are more essentially distinct from the natural structures than are any of the results of diseased nutrition hitherto considered. For these reasons, they have been called *new* and *parasitical* growths; and the term *parasitical* is the more applicable to them, because their existence and mode of growth cannot generally be traced to

variations in the local circulation, which we have found to be chiefly concerned in producing and influencing the modifications of nutrition hitherto noticed.

Morbid growths have been divided into *analogous*, those whose structure resembles some natural texture, (including false membranes, &c.;) and *non-analogous*, or *heterologous*, those which have no parallel in the healthy state of the animal economy. But this division is inconvenient, because it is applied to the other products of diseased nutrition previously arranged under another division; and it is often inapplicable, inasmuch as many morbid growths are essentially compound, comprising some forms that resemble natural textures, others that do not; yet all these are constituted of similar elementary molecules: this remark especially applies to carcinoma.

The division which I have adopted into *non-malignant* and *malignant* is more useful in a practical point of view, although it may not be easy to make it precisely applicable to all cases.

SECTION VII.

NON-MALIGNANT GROWTHS.

570. I would apply the term non-malignant to those growths which occur in a part of the body, without tending to infect other parts; and which arise among, but do not invade, the natural structures; and if they prove injurious, it is by their bulk or position, or by the extent to which they abstract the nourishment of the body.

571. The most simple form of new growth is the *serous cyst*, which is a shut sac, "containing serum, and formed of condensed cellular substance resembling serous membranes, which are formed gradually around a clot of blood, or any foreign substance in the system; and are frequently developed spontaneously in various parts of the body. They are frequently attached to the natural serous membranes, but sometimes quite separate from these; sometimes solitary; sometimes set together in clusters; and their size and shape are very various. They must be distinguished from enlargements of natural cavities, such as the calices of the kidneys, or Graafian vesicles in the ovaries. They are often unconnected with disease of the adjacent textures; but in some cases, these textures are found either wasted by absorption, (atrophy from pressure, § 532,) or disorganized by inflammation around them. There is no evidence of their being generally connected, in their commencement, with inflammatory action; and

when they are small, their existence is often not denoted by any symptoms whatever."*

Besides the instances above excepted from this class of new growths may be mentioned several others, which are rather instances of hypertrophy, dilatation, or unusual development of a natural structure, and therefore belong to a former division, (§ 528.) The enlarged bursæ, in parts subjected to pressure; the dilated mucous follicles, in the cervix uteri; the cutaneous follicles distended with fatty or other matter, (epidermis scales,) constituting the subcutaneous *adipoma* and *melliceris;* the salivary ducts obstructed and filled with concretion, in the tumour called *ranula;* are of this kind, and do not belong to the present division. I would, with Dr. Hodgkin, extend the same remark to the small serous cysts frequently found in the kidneys and liver, which I have before described as portions of secretory ducts obstructed and distended with serum, (p. 161, note.) It may be fairly questioned whether other serous cysts are not also due to enormous enlargement of the primitive or compound cells of which textures are partly composed. My friend, Dr. Hodgkin, has most plausibly advocated an opinion of this kind, and has applied it also to explain the production of more solid and complex growths, by the formation, multiplication, and compression of a series of cells.†

572. Cysts, like the serous cysts above described, are sometimes found filled with different contents, and then constitute the simplest kind of *encysted tumours*, which may form probably in any part of the body that has the cellular structure, and have received names descriptive of their contents:—" *hygroma*, when they contain a nearly serous or sero-purulent‡ (?) fluid, and form encysted dropsy if they be of very large size; *hæmatoma*, when their contents are bloody; *steatoma*, when they approach more nearly to the appearance and consistence of fat; and *atheroma*, or cold or chronic abscess, when they contain purulent (?) matter of more or less consistence, without having been preceded by distinct marks of inflammation. Sometimes substances distinct from any found in the healthy body, or substances which in the natural state exist only in individual parts of the system, (e. g., cholesterin,) are found in the interior of these encysted tumours. Those tumours of this kind which are of considerable size are often formed of a congeries of such cysts, and their contents in the same tumour are often very various, as is seen remarkably in the most common case of enlargement of the ovary, which appears

* Alison's "Outlines of Pathology," p. 231.

† Med. Chir. Trans., vol. xv., part 2.

‡ More probably, the fluid is turbid, from epithelium scales or degenerated exudation corpuscles.

to consist in gradual distension and alteration of the fluid contents of the Graafian vesicles. Further, not only the contents, but the coats or envelopes of these cysts, are subject to a great variety of changes, becoming in some cases fibrous or cartilaginous, or having bony" (calcareous) "matter deposited irregularly through them."*

573. Dr. Hodgkin considers that the complex cystiform tumour, as it occurs in the ovary, exhibits a type of the origin of morbid growths in general, not excepting those of a malignant kind. From the internal walls of one original or parent cyst, there spring a number of other cysts, varying in their contents, and as they grow, they fill the original cyst, and project beyond it, other cysts being produced within them; and thus a growth takes place, subject to modifications from the nature of the texture which is its seat, as well as from the contents of the cysts. In solid structures, as dense cellular membrane, the cysts are so compressed as to present the appearance of fibres radiating from a centre, and they lose all their liquid contents. The adjoining textures, as well as the walls of the cells, may also inflame and cohere, so as to obliterate the cystiform structure of the tumour. Professor Alison adverts to the connection between encysted and solid, or sarcomatous tumour in the commencement of the following passage:—

"In many cases, though not in all, we can clearly distinguish from these encysted tumours, (where the organized secreting substance is external to the chief bulk of the morbid growth,) tumours, the organization of which is so far different, that their substance is penetrated throughout by a vascular cellular or fibrous structure, in which they are nourished, and by which they are often divided into lobules. These are generally called *sarcomatous* tumours; and the simplest example is the common *vascular sarcoma*, which consists merely of condensed cellular substance," (well supplied with blood-vessels,) "and may be found in any cellular texture, but is often seen in the mammæ and testes. But, according to the different situations they may occupy, and the different textures of which they may consist, (sometimes, probably, from their original formation, and sometimes in consequence of their gradual transformation,) tumours of the same general structure have received different names, *adipose sarcoma*, or *ceroma*, when of fatty or waxy consistence; *polypus*, when projecting from, and often closely resembling the structure of, mucous membrane; *neuroma*, when seated on a nerve, or when growing on its sheath, and splitting up and separating its fibrils; *chondroma* or *fibrocartilaginous* tumour, when

* Alisons's "Outlines of Pathology," p. 233.

traversed by numerous bands or striæ of the consistence of cartilage; and *osteo-sarcoma*, when containing much bony deposition. In many instances, the difference in these morbid textures may be ascribed to their partaking more or less of the nature of the sound texture in which they are developed; but in some, no similarity of the diseased structure to the surrounding healthy parts can be observed. In some cases, as, e. g., in the coats of the stomach and intestines, it may be observed that the formation of such morbid growths is preceded by simple thickening and hardening of the sound cellular texture, a part of which only afterwards assumes the strictly morbid appearance."*

574. The pathological cause of morbid growths is involved in much obscurity. We cannot at present go beyond the supposition that they arise from altered vital properties in some of the molecules of the textures in which they are developed; so that, instead of being assimilated to these textures, and conforming to the laws of their growth and decay, these molecules grow of themselves in modes more or less peculiar, and more or less independently of the influences of the adjoining living parts. Where these modes are less peculiar and more dependent on the nutrition of the adjacent structures, the growths are less abnormal, vary less from these structures, and more resemble either hypertrophy (§ 525) or euplastic deposits, (§ 547,) and they do mischief rather by their size or situation than from their intrinsic nature. Where the mode of growth is more peculiar and more independent of that of the textures in which they arise, the resulting tumours are more abnormal in their nature and mode of development; they approach in character to malignant disease, acting injuriously, not only by their bulk and position, but also by abstracting the nourishment of the body, and by tending to supersede the natural structures.

575. At the outer limits of the non-malignant growths may be classed those peculiar bodies, called *hydatids* or *acephalocysts*. These are more peculiar in structure and contents than any other morbid growth, and they are quite detached from the structures in which they occur. They may therefore be inferred to possess a vitality quite independent of that of these structures. Their vitality is low, but indisputable, and is exhibited (1) in their power of self-nutrition, as manifest in the growth and the peculiar structure of their walls, which are much more elastic than any normal animal texture; (2) in their power of secretion, shown by the peculiarity of their contents, which are limpid and colourless, whatever be the nature of the matter in the serous cyst

* Alison. loc. cit.

which separates them from the living textures; (3) in their power of reproduction by gemmation, the young being developed between the layers of the parent cyst, and thrown off either internally or externally according to the species. Professor Owen* describes the hydatid to be "an organized being, consisting of a globular bag, which is composed of condensed albuminous matter, of a laminated texture, and containing a limpid colourless fluid, with a little albuminous, and a greater proportion of gelatinous substance." He adds, "As the best observers agree in stating that the acephalocyst is impassive under the application of stimuli of any kind, and manifests no contractile power, either partial or general, save such as evidently results from elasticity—in short neither feels nor moves—it cannot, as the animal kingdom is at present characterized, be referred to that division of organic nature. It would then be a question, how far its chemical composition forbids us to rank the acephalocyst among vegetables. In this kingdom, it would obviously take place next those simple and minute vesicles which in the aggregate constitute the green matter of Priestley, (*Protococcus viridis*, *Agardh*;) or those equally simple but different coloured *psychodiariæ*, which give rise to the red snow of the arctic regions, (*protococcus kermesianus*.) These 'first-born of Flora' consist, in fact, of a simple transparent cyst, and propagate their kind by gemmules developed from the external surface of their parent."

The researches of Schleiden, Schwann, and their followers, have thrown some light on the possible origin of hydatids, by showing that the primitive cells of animal, as well as of vegetable, structure, are often not unlike hydatids in their anatomical composition, growth, and mode of reproduction; for the hydatid appears to be a nucleated cell, from the interior of which are developed nuclei and nucleoli, the germs of young cells. But if it be presumed, in accordance with this fact, that hydatids are really *offsets* of living structure, capable of living detached from the solids of the body, it still remains a mystery how this divided or detached life is acquired by certain molecules on rare occasions, and contrary to the usual law. We might perhaps imagine some analogy between hydatids and the polype tribe of animals, which may be indefinitely propagated by division; and it might be conjectured that the conditions of the body in which hydatids are most commonly found, might reduce the plasma of certain parts to the standard of this mode of life; but these subjects are too speculative to be dwelt on here.

576. The situations in which hydatids have been most commonly found, are the liver, the lungs, the spleen, the kidneys,

* "Cyclopædia of Anatomy," &c., article *Entozoa*.

and the ovaries. M. Andral records an instance in which he found hydatids in the blood within the pulmonary veins; there was also a large cyst full of hydatids in the liver. The condition of the system in which they have been most frequently found to occur, is one of cachexia and mal-nutrition. They are usually contained in a serous or protective cyst (§ 571) formed by the texture around them; and the symptoms which they occasion are merely those caused by their bulk and position, compressing, displacing, and irritating organs, and causing atrophy and inflammation of their textures. In the cyst which contains them, there is commonly found more or less opaque laminated matter, which appears to be the debris of collapsed hydatids; indeed, some of those retaining the globular form often exhibit the commencement of this decay, in an opacity and wrinkling of their walls, and a changed colour of their contents.

577. The *echinococcus* is a variety of hydatid, differing from the preceding chiefly in its having a yellowish and tougher outer tunic, and in its containing distinct animalcules within it, (*vermiculus echinococci.*) It has been found in the liver, spleen, and mesentery, and rarely in the urine. The *cysticercus* is found in muscular structure, and in one instance was seen in the aqueous humour of the eye. It has a distinct structure, consisting of a cystiform body, and a head provided with suckers and hooklike processes for attachment. The *distoma hepaticum*, or *liver-fluke*, is rarely found in the human subject. It is the supposed cause of the rot in sheep, and was found by Andral and Delafond in those animals in which dropsy was present, and there was a defect of albumen in the blood, (§ 222.) The rot is a disease which chiefly attacks sheep fed in wet clayey pastures.

The subject of intestinal worms belongs properly to special pathology.

578. Little can be said on the *medical treatment* of morbid growths. To those of the kinds most approaching to the natural textures may be extended the observations applied to hypertrophy (§ 529) and euplastic deposits, (§ 552.) So far as they originate from, or are augmented by, local determination of blood, or any other kind of hyperæmia, the remedies for these morbid elements may retard the increase of the growths. But as we have found that the chief peculiarity and cause of these growths is an alteration of the vital properties of the primitive molecules of textures, little is to be expected from measures which act only on the quantity of the nutritive material. In fact, we have seen that, in many instances, morbid growths seem to originate in connection with a depressed rather than with an exalted condition of the vascular functions; and in those last

noticed, which bear more distinctly the character of parasites, the general or constitutional powers are weakened in proportion as these are developed. Hence, the general treatment indicated in such cases is of the supporting and tonic kind, with due attention to the regulation of the digestion and of the secretions. But this treatment will require modification when the morbid growths, by their irritation or pressure, excite a considerable amount of inflammation, or even of local obstruction to the circulation.

We are not acquainted with any medicinal means of correcting those alterations of vital properties in the molecules or textures from which morbid growths take their rise. The same spontaneous power which places these growths beyond the controlling influence of the laws of textural nutrition, places them beyond the reach of general remedies. The surgeon can in some instances remove the diseased part by the knife, and can sometimes further modify its properties by the direct application of escharotics or caustics, which destroy the morbid cells or germs which are the roots of the growth; and where this can be effectually done without serious injury to other living parts, the cure may be complete. It is doubtful whether the physician possesses any means of aiding the surgeon in these cases, or of controlling morbid growths which are beyond the reach of the surgeon, further than those calculated to promote the general health of the body.

In many instances, the secondary pathological changes induced by morbid growths, such as inflammation, congestion, dropsy, flux, &c., are the chief objects of treatment, and may often receive much benefit from the usual remedies; but the extent of this benefit is commonly limited, as to extent and time, by the permanency and intractability of the morbid growth, which is their cause. Thus, with encysted dropsy of the ovarium, peritonitis, ascites, and œdema, obstruction of the intestines, and other secondary functional disturbances, generally admit of relief for a time; but as the ovarian tumour remains, and increases in spite of all remedies, the resulting disorders recur again and again, and at last prove fatal. But the growth of the cysts themselves, although generally progressive, is sometimes very capricious—being sometimes very rapid; in other instances, even in the same case, it may remain stationary for years. Nay, cases are not wanting, although rare, in which encysted tumours have altogether disappeared: as after the operation of tapping, or even spontaneously, by rupture, into some of the natural cavities. But such instances, although they show a variety, exhibited by morbid growths, not to be forgotten in connection with prognosis as well as treatment, are to be considered rather as exceptional cases, than as those following the usual rule.

SECTION VIII.

MALIGNANT GROWTHS.

579. *Malignant growths* are distinctly organized structures, arising in various textures of the body, invading these textures with their own peculiar substance, and often appearing successively or simultaneously in several parts of the body. They prove injurious, and eventually fatal, not merely by their bulk and position, (§ 569,) but also by the change of structure which they may induce in various organs; by the intractable ulcerations and fungous wounds to which they tend; and, lastly, by a wasting and deleterious influence which they seem to exercise on the whole functions and structures of the body. In all these points, the most malignant growths exhibit a character perfectly distinct from the more simple, harmless growths, hitherto described; but it must be observed, that the degree of malignancy varies very much in different cases, by one or more of the preceding characters being absent, or not yet well developed; and consequently, that morbid growths or tumours are occasionally met with, which present a doubtful or intermediate character between non-malignant and malignant.

580. The names *cancer* and *carcinoma* (from the supposed resemblance of the diseased structure to a crab, *cancer*, καρκινος) have been long applied to the whole genus of malignant growths, which comprehends the following varieties:—*Scirrhus; mammary, pancreatic, and solanoid sarcoma; encephaloid* or *medullary sarcoma; fungus hæmatodes;* and *colloid* or *gelatinous cancer.* That these are all varieties of the same disease may be inferred from the fact, that they more or less resemble each other in the characters of malignancy above described; and that they frequently occur in the same subject, either simultaneously in different parts, or successively in the same part. Thus a person who has long been affected with scirrhus of the breast, often dies with medullary sarcoma in the liver or lungs; or after a scirrhous tumour has been removed from any external part, an encephaloid or fungous disease may subsequently appear in its place. The varieties may, for the most part, be traced to different degrees of activity in the *specific* or *cancerous matter,* that may now be stated to be the *materies morbi,* and to the varied changes in the new growth, and in the implicated textures which this matter, thus differently active, can produce. Of these varieties, it may be said generally, that scirrhus, and perhaps the mammary and the pancreatic sarcoma, exhibits a *chronic* character, with less activity and tendency to increase locally or to spread through the

system; whilst the others constitute the more acute forms of cancer, causing more rapid growth in the parts first affected and more speedily appearing in other parts of the body.

581. The peculiar matter of cancer is distinctly a structure, consisting of nucleated cells and molecules, contained in an areolar or fibrous web of very various density. Of these, the cells must be considered the first elements; and although they present some variety in form, they are constantly found in every kind of cancer. These cells are chiefly globular, and retain that shape in the soft, gelatinous kinds of cancer; but in others, many are candate or spindle-shaped, as if in the process of transformation into fibres. In scirrhus, and other more solid and chronic forms of cancer, the fibrous structure is more abundant, and is very perceptible to the naked eye, forming glistening striæ or bands radiating through the mass, of cartilaginous hardness; the cancerous cells and numerous granules are seen between these fibres, and accompany them to their outermost branches. In the cerebriform or medullary kind of cancer, the nucleated cells are very numerous; and the texture in which they are contained is cellular, and well supplied with vessels. This is the species in which the growth is most rapid, and in which, from the extravasation of blood in the loose new texture, a bloody aspect is given to parts of it, whence the name *fungus hæmatodes.*

582. The intrinsic disposition to grow, even at the expense of the nutriment of other parts of the body, which was mentioned to be a character of some formations not distinctly malignant, (§ 574,) is exhibited in a much higher degree in malignant structures, the increase of which may take place most rapidly when all the natural textures are wasting away. This fact again suggests the idea of an independent vitality possessed by these structures, in virtue of which, like parasitic animals or plants, they luxuriate at the expense of the whole frame. The question next arises—Are these growths truly parasites, arising from ova or seeds derived from without the body, and after entering it, and finding a proper nidus or soil, taking root or becoming developed as a distinct being, like worms or hydatids, only drawing its nourishment from the fluids and solids of the body? If it be objected that malignant growths are too closely attached to, and too much identified with, the textures of the body to permit the notion of a distinctness of being, it may be replied, that cancerous cells, their most distinctive part, are often loose and unattached: they propagate themselves by the production of young cells within them; and it has been proved, by an experiment of Professor Langenbeck, that the cancerous pulp containing these cells is capable of propagating cancer in animals on being injected into their veins. This positively identifies cancer with contagious

diseases, respecting the causes of which we formerly noticed questions like the present, as to their parasitic nature, (§ 99.) Contagion is not, however, a common cause of cancer; the only example ever adduced being a rare one of the penis becoming infected by a carcinomatous os uteri. Further, it has been well remarked by Dr. W. Budd,* that the causes which have been supposed to induce cancer are not such as can, in any intelligible way, favour the introduction of germs from without the body. Thus, in chimney-sweeps and others, the continued application of soot has been observed to be followed by the occurrence of cancer in the scrotum, in such a number of cases, as to justify the inference that it has been the exciting cause. The often repeated contact of a tobacco-pipe with the lip has also been considered a cause of cancer of that part. But neither of these causes can, in any conceivable way, promote the development of cancer from extrinsic germs.

The alternative that presents itself is, that cancerous growths may arise from a peculiar perversion of the natural nutritive process, similar to those modifications which we have been induced to suppose are the causes of the more peculiar kinds of common growths; but in the case of malignant disease, the perversion is much greater in degree, and shows itself, not only in its origin, but in its whole subsequent history. It can be conceived possible, that causes long acting locally, as the soot on the scrotum of chimney-sweepers, the tobacco-pipe on the lips of inveterate smokers, the irritations of the stomach connected with habitual dyspepsia, and of the uterus from irregular menstruation, &c., may induce this extraordinary alteration in the molecular nutrition of these parts; but we cannot hereby at all explain the peculiarity of this alteration, which must therefore be viewed as an ultimate fact in connection with nutrition. In other words, if we assume that cancer cells are modifications of the natural cell-germs by which textures are produced and nourished, we do not thereby explain (or refer to a known law) the extraordinary anomalies of the independent vital properties and consequent growth of these modified cells, which are obviously different from that of texture cells in general, and derive much of their destructive effects from such difference. It remains for future investigation to establish the law of that difference. We have before stated, that Dr. Hodgkin has proposed a plausible hypothesis with regard to these and other growths, that they originate in cysts, (not cells or microscopic cysts, but larger ones, which comprise these;) and that the multiplication of these cysts within each other, their prolongation into radiated fibres, their pressure on adjoining textures,

* Remarks on the Pathology and Causes of Cancer, *Lancet*, May 28, 1842.

and consequent inflammation, induration, ulceration, atrophy, or gangrene of these textures, comprise the whole history of malignant growths. What appears to me to be chiefly wanting to establish Dr. Hodgkin's views is, a more distinct demonstration of the supposed cysts, which, at the commencement, or at the outer limits of cancerous growths during their spread, ought to be distinctly visible.

583. But although the precise origin of malignant growths is still a matter of uncertainty, some important practical facts may be gathered from their pathology. Their microscopic structure and history pretty clearly show that they are of local origin; that they extend by the multiplication of their cells, which, by perverting the nutrition of the adjacent parts, cause the growth of the tumour; that they ultimately infect other parts of the body, by spreading to the nearest lymphatic glands, and by the mixture of their cell-germs with the blood, (§ 259,) which form new tumours in the liver, lungs, or other vascular parts, (the same as those in which purulent deposits take place, and for similar reasons, § 470;) or the cancerous matter is sometimes found in clots within blood-vessels, or in the coagulable lymph effused by inflammation.*

But the history of malignant growths comprises not only that of the development of the cancerous structures in different degrees and forms, but also their effect on the adjacent textures; and it seems to me possible, by a due regard to these two elements, to explain much of the varieties which cancerous disease presents. Thus scirrhus is the slowest form of the disease, because it generally occurs in persons above the age of forty, in whom the textural nutrition is tardy, and the cancerous matter is but slowly developed: the effect on the adjacent textures is to excite inflammation of a chronic form, and therefore leading to induration, and often to contraction, (§ 479,) and more or less obliteration of the natural textures. Hence the hard, knotty, corrugated swelling of scirrhus of the mamma, rectum, pylorus, &c., which may be attended with more or less pain of a peculiar stinging or lancinating character, besides various functional disturbances, (obstruction to the passage of food or fæces, severe dyspepsia, vomiting, &c.) The continuance of irritation in the indurated parts leads (as usual) to ulceration, (§ 466.) This constitutes what is called *open cancer*, with ragged, inverted, or everted edges, and a fungous or sloughy interior, discharging a dark, offensive, ichorous matter. That such ulcers should be wholly incapable of healing is quite intelli-

* In a case (which I lately saw with Mr. Avery) of malignant disease of the lungs and deep cervical glands, involving the 8th nerves, there had been recent pleurisy, and the bands of false membrane were glistening, and grated under the scalpel from the presence of cancerous fibres.

gible, when it is remembered that its walls are composed of the cancerous structure and the compressed remains of the natural textures, whose secretions are too poor and too much perverted to afford euplastic secretion. The ulcer may prove an outlet for the increasing cancerous matter; and if the discharge be checked by external means, the disease is more likely to spread or to attack other parts: as the ulceration destroys the indurated mass, and thus removes the barrier between the cancerous germs and the healthy textures, there is greater chance of the body becoming more generally infected. Hence, too, from the multiplication and diffusion of the germs, the secondary malignant growths that may appear in other parts are often of the softer, more rapidly growing kinds. The influence of scirrhous cancer on the whole frame, although more slowly induced, perhaps for this very reason, is carried to a greater degree than that of any other form of cancer. Emaciation sometimes reaches a point unequalled in any other disease; and the wasting, of which this is the sign, extends to the composition as well as to the bulk of organs and textures. Thus bones lose much of their animal matter, and become so brittle, as sometimes to be fractured from the slightest violence. All membranes become extremely thin; the omentum often wastes away, excepting a few threads. The lungs exhibit a remarkable lightness, in weight and colour; and I have seen the old cicatrices or consolidations, so frequently found at their summits, thinned and almost as pliant as other parts of the pulmonary texture.* But nothing is more remarkable than the exsanguine state of the textures generally; and this condition is obvious during life in an extreme pallidity, often associated with a sallowness or peculiar lemon-tint of complexion, that has been observed to be peculiar to cancerous subjects.

Scirrhus chiefly occurs above the age of forty; and the more advanced the age, the slower generally is the progress of the disease. It has been remarked, by Sir Charles Bell, Sir Astley

* It appears to me, that the rare coexistence of tubercle with cancer, as noticed by some writers, is to be ascribed to the former being removed by absorption, during the extraordinary wasting of textures which attends chronic cancer. I have twice found, in the bodies of persons who died of cancer, considerable remains of tuberculous deposit at the apex of the lungs, without any tubercles in other parts. In one case, masses, partly caseous, partly calcareous, of the sizes of a pullet's and a pigeon's egg, were thus found encysted by a thin membrane. In another, a cavity communicating with the bronchi, taversed by a band of dense tissue, like that found in tuberculous cavities, and lined with a thin, smooth membrane, was in the middle lobe. In all these cases, the other parts of the lungs were free from tubercles. Now, it does not appear probable that such considerable tuberculous deposit should have taken place without some in other parts also. We meet with no case of recent tubercle thus limited to one portion of the lung. These and similar facts connected with the emaciation of old age, seem to me to furnish strong arguments in favour of the absorption of tubercles.

Cooper, Mr. Travers, and others, that scirrhus of the breast, which will run a comparatively rapid course at the age of forty-five, will remain stationary for years, and hardly appears to shorten life at the age of sixty or seventy. This shows the share which activity of textural nutrition has in causing the increase and dissemination of cancerous disease. It is under such circumstances that operations for the removal of the disease have been most successful; but it must be remembered, also, that in such cases they are less strongly called for.

584. The *pancreatic*, *mammary*, *lardaceous*, (or pork-like,) and *solanoid*, (or potato-like,) forms of cancer appear to be intermediate between scirrhus and encephaloid disease, increasing more rapidly than the former, yet approaching to it in firmness. They are attended with less pain, from the smaller degree of tension and induration which they cause in the implicated textures. For the same reason, they are less disposed to ulcerate (§ 466) or slough, (§ 474;) and they commonly prove fatal, either by their growth and encroachment on some vital part, or by leading to the dissemination of cancerous deposits in other parts of the system.

585. *Encephaloid*, (brain-like,) or *medullary sarcoma*, is the acute or rapid variety of cancerous growth. It occurs chiefly in young and middle-aged subjects, and in the most vascular textures; and it may be fairly connected with the activity of their molecular nutrition. This may be the cause of the rapid increase of the cancer-germs or cells, (if these be indeed mere modifications of the cell-germs of textures;) but much of the speedy growth and early dissemination of this variety of cancerous disease, must be attributed to an active plastic process, which the presence of the cancerous matter excites in the vascular textures in which it lies. The mass of encephaloid tumours comprises false membranes, lymph, and even coagula of blood, in various degrees of organization: among and between these are found the cancerous cells, which luxuriate and rapidly multiply in so fertile a soil. It is in connection with tumours of this kind that the fact before noticed has been observed, that coagula in the neighbouring veins have exhibited the encephaloid appearance; and so has coagulable lymph, produced by inflammation of serous membranes or parenchymata of organs. The speedily destructive influence of this kind of cancer is mainly to be ascribed to the rapid dissemination of the cancerous matter, and the bulky depositions which it induces around it, which, although organized, and highly vascular, are beyond the controlling influence of the powers of assimilation or absorption, and consequently stuff, obstruct, and compress organs to a fatal extent. The facility of growth in these tumours receives some explanation in the varicose condi-

tion of their vessels, as ascertained by Mr. Kiernan, and their free communication with arteries, (§ 420,) as pointed out by Schroeder Van der Kolk. The same circumstance, together with the general softness and looseness of their texture, accounts for the facility with which hæmorrhage takes place into their substance, (§ 357,) causing an appearance that has led to the use of the term *fungus hæmatodes*. These forms of disease commonly prove fatal before the emaciating effects, so remarkable in scirrhus, have advanced far.

586. The *colloid* or *gelatinous* (*areolar* of Cruveilhier) variety of cancer seems to me to represent the cancerous element almost in a separate state, little mixed with natural tissues or their products. According to Müller, it consists chiefly of cells contained in a very slight loose web; the cells are larger and rounder than usual, and contain small cells, which also contain cell-germs. The peculiar germinal principle of cancer is here, therefore, very abundant and prolific; but the nutritive secretion of the surrounding textures is not equally copious: therefore no distinct growths are formed; but the gelatinous matter is found infiltrated into the webs of textures, chiefly in connection with advanced stages of other forms of the disease.

Further varieties have been described, by Dr. Carswell and others, according to the particular form which the cancerous growth assumes, such as the *tuberiform*, *stratiform*, *ramiform*, &c. They are probably connected with the anatomical construction of the parts in which they appear, together with the quantity and rapidity of development of the new growth.

587. Another morbid production that has generally been classed among malignant growths, because it affects many textures and may supersede them, is *melanosis, black cancer*, or *black tubercle.* It most commonly occurs in the form of a loose cellular tissue filled with the peculiar black matter suspended in a serous liquid; but sometimes its substance is quite compact, and resembles crude yellow tubercle, or the lardaceous form of cancer. I have a drawing which I made of a lung exhibiting a combination of encephaloid disease with melanotic tumours, the latter of compact texture, like nodules of pulmonary apoplexy, and varying in colour from a dark bistre brown to a deep jet black. The combination of melanosis with carcinomatous tumours has also been noticed by Cruveilhier and Carswell. Andral describes melanosis to occur in four forms:—“ (1) It pretty frequently constitutes masses, encysted or otherwise; (2) the matter which composes it may, like the tubercular matter, be infiltrated into different tissues; (3) it may be spread like a layer, of greater or less thickness, on the free surface of membranous organs; (4)

it may exist in the fluid state, either pure or mixed with other fluids."*

The peculiar characteristic of all these forms is the black matter, which, from the analyses of Dr. Fyfe, M. Thenard, and M. Foy, appears to be a highly carbonized insoluble matter, supposed to be altered colouring matter of the blood. It has been compared by Andral to the black pigment of the eye, and he considers it to be identical with the black matter commonly found in the lungs and bronchial glands. The colouring matter of the blood certainly is sometimes changed into a perfectly black matter, as in the black vascular striæ and patches in the intestinal canal, particularly in chronic inflammation, where the blood has been effused or retained in vessels, and altered by the intestinal secretions and gases. These black appearances are called by Dr. Carswell spurious melanosis. Again, the black pulmonary matter is merely a carbonaceous powder contained in the interstices of the textures, and sometimes in the vessels of the lungs and bronchial glands; but whether it also proceeds from the colouring matter of the blood in an altered state, or is truly a deposit of carbon, is uncertain. All that is requisite to produce a black carbonaceous deposit in the colouring matter of the blood is the abstraction of a certain amount of hydrogen, which the mineral acids are capable of effecting; and it seems not improbable that such a change takes place naturally in the formation of black pigment through the operation of peculiar cells, (pigment cells,) and as a result of disease in melanosis.

But this production of black matter may coexist with various modifications of the nutritive process; plastic, as in cellular and membranous melanose tumours; cacoplastic, as in the hard black tubercle, and in the black consolidation of chronic pneumonia; and aplastic, as in the combination of black with opaque caseous matter, not unfrequently found in the lungs and bronchial glands. So, too, it may be, as we have seen, combined with various forms of malignant disease; but, with Andral, I hesitate to class simple melanosis with malignant growths.

588. The *treatment* of malignant disease has been generally considered to belong rather to surgery than to medicine, and yet the utility of removing malignant growths by operation has been generally deprecated by surgeons down to the present time, when they may again learn, chiefly from the investigations of physicians, when and why operations may be expected to be successful. The indications of treatment which are suggested by the foregoing account of malignant disease may be summed up under three

* "Pathological Anatomy," (Transl.,) vol. i. p. 249.

heads:—(1) to extirpate the malignant growth; (2) to retard its development; and (3) to counteract its effects.

The complete extirpation of malignant growths can be effected only when they are quite local, so that when removed by the knife or by caustic, no root nor stray germs of the disease shall be left behind. We have adduced reasons to suppose that at its first origin cancer is entirely local, and that if it be completely excised at an early period, a cure may be effected. For this success, it is essential that every cancerous cell be removed; and Dr. Hodgkin has recommended the careful examination of the portion removed, to see that it contains on its surface none of those grains consisting of an aggregation of cancerous cells, which can be seen even with the naked eye in cancerous structure. Dr. W. Budd recommends the use of the microscope for the same purpose: "If the characteristic cells were found on the cut surface of the portion removed, it would be morally certain that others have been left behind, and that the extirpation is incomplete, although, on the other hand, the absence of these cells would be by no means so sure a guarantee of their entire removal. Such an examination would, however, always be a matter of great interest to the surgeon."* The best security would lie in the operation being performed before the constitution has been in any degree impaired by the disease; and particularly before any neighbouring parts, especially lymphatic glands, have shown any indications of disease. The best chance will therefore be afforded in cases in which the growth is most chronic and inactive, and of the smallest extent, as in scirrhus of the lip, skin, or breast. If any cancerous texture or germs are left behind, the operation is likely to do harm instead of good, by bringing them into activity, and developing the acute form of the disease. Cases have occurred in which a cancerous breast has been completely removed by a spontaneous sloughing; but such an event is extremely rare. Cauterization is less advisable than excision, being less manageable.

589. The second indication, to retard the development of the malignant growth, is chiefly to be attempted by means which diminish the circulation through the diseased part. Repeated local bleedings have been found useful, partly perhaps in this way, but more by relieving the inflammation excited by the growth. The best means for staying the growth of malignant disease is by pressure, which has long had many advocates. Such a kind and degree of pressure as will reduce the circulation through the part to the lowest degree compatible with its life, will pretty surely arrest the increase of the morbid growth, by

* *Lancet*, May, 1842.

depriving it of its nutriment. But for the utility of this measure it is equally necessary that the disease shall not have extended to other parts besides those to which the pressure is applied, otherwise in those parts, which are commonly internal, the growth will proceed with an increased rapidity, proportioned to its suspension by the pressure on the outward part. The best means of applying pressure are those contrived by Dr. Arnott, especially the slack air-cushion under a compress. It is very doubtful that we possess any means of influencing malignant growths through the constitution. Various medicines have enjoyed an ephemeral repute for their efficacy in cancer. Of these, conium has been one of the most favourite. Dr. A. T. Thomson considers the iodide of arsenic to possess some power in controlling the increase of cancers. But it is doubtful that any of these remedies do more than soothe irritation, and restrain common inflammation and its results, with which malignant growths are generally complicated.

590. The third indication, to counteract the effects of morbid growths, is more commonly the object of treatment; but the means of fulfilling it fail more and more as the disease advances. The use of narcotics of every description, general and local, to soothe the pain and irritation, and of occasional local antiphlogistic measures to remove inflammation and congestion, is commonly admitted in palliation of malignant disease; but the importance of tonics and nutritive diet to counteract the increasing cachexy and emaciation is not so generally regarded. Yet these have appeared to me to have considerable efficacy in supporting the constitution and supplying it with strength against the enemy that is preying on its vitals. Preparations of iron, when borne, are the best tonics.

SECTION IX.

DISORDERS OF MECHANISM.

591. Many structural diseases arise from changes in the mechanism of organs, which are not precisely implied in any of the preceding elements. It is quite needless to enter into a detail of these alterations of mechanism; but to complete our key to the elements of disease it will suffice to cite a few examples.

Hollow organs are liable to *dilatation* from an undue accumulation of matter within them. Thus the heart, arteries, and veins, the air-cells of the lungs, portions of the intestinal tube, the bladder, &c., become distended when there is an obstruction to the passage of their respective contents, or when the expulsive power by which they are contracted is weakened; and such distension, if long continued or frequently repeated, becomes a permanent dilatation.

Parts may become overstretched and relaxed by a loss of natural cohesion or elasticity; thus, ligaments, tendons, and fasciæ, become relaxed and ineffectual in binding together or connecting the parts to which they are attached.

592. *Contraction* is the opposite of dilatation. It may constitute *stricture*, and lead to the partial or total obstruction of parts of the canals of the intestines, urinary and respiratory apparatus, vascular systems, &c. The influence of contraction of the texture of organs and of serous membranes, we have several times had occasion to notice as the results of disease.

593. Parts may be *ruptured* or *lacerated*, either from previous disease or from violence, and structural disease is the result. Thus, hollow organs, the heart or arteries, the stomach, the gall bladder, the urinary bladder, have been ruptured with speedily fatal results. Rupture of the valves of the heart, of portions of blood-vessels, of air-cells, &c., injures the mechanism of these parts, and forms an element of structural disease.

594. *Displacements* and *compressions* of organs are frequently the effect of tumours or effusions, as in the case of the tumour of ascites, or ovarian dropsy, or an enlarged liver, pushing up the heart and lungs, and variously compressing and displacing the abdominal viscera; of an enlarged heart or aneurism displacing and compressing the lungs and air-tubes; effusions in a pleural sac, compressing the lung of that side, and displacing the heart, mediastinum, diaphragm, liver, and the walls of the chest.

595. *Contortion* of rigid parts is exemplified in rickets, mollities ossium, and rheumatic nodosities of the joints. Curvature of the spine, besides shortening the length of the trunk, disorders also the mechanism of respiration, by changing the position of the ribs; and when the distortion is great, the function of the heart and great arteries, and of the abdominal viscera, may likewise be affected by it.

CHAPTER V.

THE CLASSIFICATION, SYMPTOMS, AND DISTINCTION OF DISEASES.

SECTION I.

NOSOLOGY.

596. Having considered the causes of disease, their mode of operation, the resulting effects on function and structure in the ultimate and proximate elements of disease, and the remedial influences which can be brought to remove or counteract these elements; we have next to notice the manner in which these elements of disease affect the several parts and functions of the body, the symptoms which they induce, and the combination or forms which they present, as *special diseases.* In order thus to allot together in distinct divisions the wide domain of disease that has been displayed by general pathology, it is necessary to *define* special diseases—that is, to designate their peculiarities by short descriptions, and to group and subdivide them in classes, orders, genera, and species. This classification and definition of diseases is usually implied by the word *Nosology.*

597. Diseases may be classed in different ways. The first method attempted was a classification according to their most prominent phenomena or symptoms. Of this kind was the system of Sauvage, who divided diseases into ten classes:—*vitia, febres, phlegmasiæ, spasmi, anhelationes, debilitates, dolores, vesaniæ, fluxus, cachexiæ.* The classifications of Linnæus, Vogel, and Sagar, were also of this kind, which may be termed artificial; and Cullen's division was a strained simplification of the same description of arrangement, condensing all diseases into the four classes:—*pyrexiæ, neuroses, cachexiæ, and locales.*

The chief objection to this, which may be called *symptomatic nosology*, is, that it regards symptoms as the essence of diseases, whereas they are really extremely variable, both in their kind and severity, and by no means uniformly correspond with the nature or with the amount of the real change of function and structure present. Hence, too, similar symptoms, from the most diverse causes, are classed together, although they may require quite opposite plans of treatment; whilst diseases that are really kindred in their nature, are widely separated, because they differ in their symptoms. The artificial method of classification is admissible only as a provisional means of arranging subjects in a conventional way, until the true nature of these subjects is investigated; when this is done, or even as it advances, the artificial method should give place to the natural one, which is not a mere glossary of names, (or symptoms,) but in itself expresses the most important points of knowledge of the nature of the subject.

598. The true foundation of a natural classification of diseases is in a correct pathology, or knowledge of the intimate nature of diseases; but the subdivisions are conveniently determined by the chief seat of the disease, or by other of its more prominent characters. The classification of Pinel approaches to this standard, although it is necessarily imperfect from the infant state of pathology at his period. He divided diseases into five classes:—*fevers, inflammations, hæmorrhages, neuroses, and organic affections.*

Pathology may be applied to the classification of diseases in two modes. In one, it is the first step in the arrangement, all diseases being distributed in classes expressive of the several pathological elements affecting the systems defined by general anatomy. Thus, according to the groups of pathological elements which we have reviewed, the *classes* might be—diseases of the muscular system, those of the nervous system, of the secernent system, of the blood, of the vascular system, and of nutrition. The subdivision of these classes into *orders* would be determined by the individual pathological elements: thus, diseases of the muscular system would be divided into those of irritability and those of tonicity, with the *generic* subdivision according to excess, defect, or perversion; and, lastly, the *specific* distinctions would be made according to the organ or locality affected. This arrangement is not suitable for clinical or practical purposes, because diseases are generally too compound to admit of being classified according to their elements: they commonly comprise several pathological elements, and the proportions of these elements vary with the progress of the case.

599. The other mode of using pathology in nosology, is by making it subservient to establish those divisions or subdivisions in which the character of the elements of diseases affords an obvious and natural mean of distinction, which may be useful in their diagnosis and treatment, whilst the remaining divisions are derived from the situation or other circumstances of the diseases.

Thus diseases may be classed according to their chief locality, the organ or set of organs which they affect. Thus, as *classes* of disease, we may have, diseases of the *organs of respiration;* diseases of the *organs of circulation;* of the *apparatus of alimentation;* of that of *urinary excretion and of generation;* of the *nervous system;* of the *organs of locomotion;* of the *skin;* of the *blood;* and lastly, *general diseases,* having no defined seat. The division of these classes into *orders* is founded on pathology: thus, each class comprehends *functional* diseases, subdivided into diseases of *irritability, tonicity, sensibility,* &c., and *secretion;* and *inflammatory* and *congestive* diseases; and diseases of *nutrition, (structural.)* A further division into *genera* and *species* is made according to the anatomy of the parts: thus, of the class,—*diseases of the organs of respiration;* order, *functional disorders;* genus, *irritability*—the species would be *spasm* or *paralysis of the larynx, of the bronchi,* &c. But in general diseases, the subdivisions must be altogether pathological, or founded on causes or symptoms: thus, *fevers* are distinguished into *inflammatory, eruptive, adynamic,* or *contagious* and *malarious,* or *intermittent* and *continued,* as each of these modes of distinction becomes most available.

This last classification, although it may be less pure and methodical than others, is the most useful in practice, because it most closely follows nature; and, setting aside more minute and difficult distinctions, it leads to the seat and nature of the disease, and renders available those general principles in pathology and therapeutics which form the foundation of rational medicine. A chief recommendatien of this kind of nosology, or arrangement of individual diseases, is, that whilst it includes all diseases hitherto distinguished, it points out others which may and do occur, but for want of distinct pathological views and names have been confounded with others more prominently defined.

600. The *definitions* by which individual diseases are designated may refer either to the pathological nature of the disease or to its characteristic symptoms, or to both, and in some instances, the causes or results of the disease form a characteristic part of its history. It should be remembered that the great purpose of nosology is to arrange and define diseases in such a manner that their true nature, with the chief points of affinity and difference between each other, may be expressed by the arrangement and definition; and whether these points of affinity or difference are most manifest in the causes, nature, or symptoms of the diseases, the arrangement and definition should duly regard them. Thus, besides its chief peculiar symptoms, the definition of a distinctly infectious disease, as scarlatina, should express its infectious character; that of a disease indubitably caused by marsh mias-

mata, as ague, should imply this fact; whilst, by both being classed as *general* diseases, and in the order *fevers*, the one of the genus *eruptive*, the other of the genus *intermittent*, much of the nature of the diseases, as well as of their distinguishing characters, will be set forth by this nosological arrangement. The further that our knowledge of pathology is advanced, the more considerable a part will it form in our nosological systems; but in the meantime it is better to render our classification and definitions as useful as possible by deriving them from *all* the most available sources of information, than to keep them imperfect and inapplicable until science is sufficiently advanced to supply us with a system that is quite pure.

As we do not enter upon *special pathology*, or the history of individual diseases, it is unnecessary to proceed into the details of nosology. The foregoing remarks are intended merely to explain the objects of nosology, and to introduce the two associated subjects, *semeiology* and *diagnosis*.

SECTION II.

SEMEIOLOGY AND DIAGNOSIS.

601. *Semeiology* treats of *signs*,* and in medicine, of the *signs of disease*. The word *symptom* is commonly used in the same sense as *sign;* but, as its etymology implies,† it is a more vague expression, signifying *coincidence* or *co-occurrence* rather than a direct or constant connection. It has been attempted by some writers, (particularly French,) to restrict the word symptom to the phenomena manifested by present disease only; but this is contrary to the usual custom by which we speak of *precursory* and *consecutive symptoms*, *symptoms of health*, &c. Again, some have confined the term *symptom* to the phenomena depending on vital properties, whilst those phenomena of disease which are more directly physical they call *signs*. This was the sense in which Laennec used these words, and others have followed his example. Although this acceptation of the word is not in strict accordance with former usage or with their etymology, yet it would be convenient for conventional use; and to render it more precise, it will be well to prefix the epithets *vital* and *physical*, as first suggested by Bayle, and partially adopted by Laennec.

Let us then understand the word *sign* of disease generally to

* "*Sign*, that by which any thing is known."—Johnson's Dictionary.

† Συμπτωμα, from συν, with, and πτοω, to fall.

imply, any thing by which the presence of disease may be made known. A *symptom* is any phenomenon which becomes obvious in the course of disease; it may thus often prove to be a sign; but many symptoms are of such uncertain connection with a particular disease, that they cannot be said to make known the presence of a disease, and therefore they cannot be called signs. The more specific designation of *physical signs* and *vital symptoms* will succeed better in attaching a distinct meaning to the different phenomena of disease; and by stating briefly the grounds of this distinction and the proper application of the terms, we may be able to point out the respective value of each class of phenomena to which they are properly applied.

602. *Physical signs* are those physical properties of the body, or of a part of it, which are perceptible to any of the senses of the observer. Thus, the form, size, colour, firmness, or softness, weight, heat, and odour, of the whole body, may be said to give physical signs or evidence of its condition, whether in health or in disease. So, also, the form, size, colour, resistance, position, temperature, smell, and acoustic properties of a part of the body, afford physical signs of its condition, whether in health or in disease. Thus, the appearance of an external disease, the feeling of a solid tumour, or of the fluctuation of liquid in the abdomen, listening to sounds produced by or in diseased internal parts, furnish us with physical signs of the presence of disease.

The difference between the signs of health and the signs of disease is determined by our knowledge of what is usual in health, and this knowledge may be derived (1) from general observation or experience of healthy standards, or (2) from anatomical and physiological knowledge of what the phenomena of health ought to be; or (3) from a particular knowledge of the standard of health in any individual case.

All of these healthy standards of comparision are available: the first is less exact than the other two; but it is often available for obvious disease. Thus, a jaundiced hue of the body, extreme pallor, or great emaciation, afford to the common observer physical signs of disease which cannot be mistaken. But slighter degrees of the same signs may become manifest only to those who, by previous acquaintance, know more exactly the standard of health in the individual, and can distinguish a change in colour or in flesh from that standard. Again, in local disease: a large tumour or swelling in a part is a sign of disease obvious to every one; but a smaller or more deep-seated tumour may be discovered only by those who have an accurate knowledge of the healthy anatomy of the part, or by those who by previous observation have made themselves familiar with the shape and feel of the part in health.

603. Another standard available to distinguish the physical signs of disease from those of health is a comparison of parts that are naturally symmetrical. Thus, a slight swelling in one limb may be readily discovered by comparing it with the corresponding part of the opposite limb. A projection or contraction of one side of the chest may escape observation until the two sides are compared by inspection or by measurement, which will detect the difference between parts that are naturally alike. This standard of symmetrical comparison is applicable, not only to all external parts and to organs of animal life, but also to some internal parts, which, although not strictly symmetrical, are so far equally distributed on the two sides as to give symmetrical properties to the exterior. Thus, the lungs, in health, fall so equally on both sides of the chest, that they give corresponding motion and acoustic properties to both; and percussion or respiration yields similar signs on both sides. So, when disease affects one side, it changes its physical signs, and their difference becomes obvious by comparison with the signs of the healthy side. A certain degree of uniformity also results from the position of the viscera in the abdomen, so that (making allowance for the greater bulk of the liver on the right side) any considerable difference in the shape or resistance of the two sides may be interpreted to be a sign of disease.

604. For organs which are not symmetrically placed, previous knowledge of their natural structure, position, and physical properties, is necessary. Thus, we cannot know the physical signs of diseases of the heart and liver, without having a healthy standard to compare them with. This standard is soon supplied by the observation of the signs in health, and our knowledge of it may be much assisted by a familiar acquaintance with anatomy and physiology, which teach the healthy condition and functions. Thus, anatomy teaches us that the heart lies behind the lower half of the sternum and the adjoining parts of the cartilages of the left ribs from the third to the sixth; and physiology makes us acquainted with its regular double sound heard in this region: these furnish a healthy standard, and when we compare it with a case in which the impulse of the heart is felt to beat over a much wider space, and the sounds are irregular and masked by grating or blowing murmurs, we at once discern these phenomena to be signs of disease. Again, anatomy informs us that the liver in a healthy adult extends little, if at all, below the margins of the ribs on the right side; and the knowledge of this fact points out as a sign of disease such dullness on percussion and resistance to pressure below these ribs as arise from the liver reaching much below its usual situation. The knowledge of the healthy mechanism and functions of the apparatus of respiration, circula-

tion, digestion, and excretion, is in many respects necessary to enable us to distinguish the signs of disease from those of health; it will guide us to refer the signs to their true causes; and it may often suggest the particular signs which may be expected to arise from a particular lesion.

605. Physical signs are phenomena taking place in the body, in accordance with physical laws. It is therefore obvious, that a knowledge of these laws, as well as of the mechanism of the body, will assist us to interpret these phenomena; to explain of what they are signs, how they are caused, the variations which they may present, and the best mode of appreciating them. Thus an aneurism of the arch of the aorta may be chiefly detected and studied through the physical signs which it produces. It forms a tumour under or near the top of the sternum, pulsating in a distinct manner, and with a peculiar sound; this tumour may press on the air-tubes in such a way as to alter their shape, and by partially obstructing the passage of the air through them, may also change the sound of breathing in a particular way: by compressing the veins, it may also throw their current into unusal sonorous vibration; or by a more complete obstruction, it may cause the veins to swell in a remarkable degree above the tumour: by its enlargement, the aneurism encroaches on the lungs, the walls of the chest, the muscles, nerves, bones, ligaments, &c., in such a way, as to alter their physical properties and positions, and thus to produce various physical signs. Now, all these physical signs are phenomena produced in the altered mechanism, according to certain laws; and it is plain, that a knowledge of these laws must greatly assist us to understand the signs, and to trace them to their true causes. Nay, even the aneurismal tumour itself, in its production, increase, and intrinsic signs, can be rightly understood only through a knowledge of hydraulics and dynamics, in connection with the structure of the heart and arteries in health and disease.

606. *Vital symptoms* are those phenomena which depend on *vital* properties of a part or parts of the body. Thus irritability, tonicity, sensibility, excitomotion, secretion, and the more complex functions resulting from combinations of these elementary vital properties, (§ 104,) in a natural state, produce the symptoms of health; in an altered state, constitute the symptoms of disease. Hence vital symptoms have also been called *functional* symptoms, and *physiological;* but both these terms are objectionable, because both *function* and *physiology* relate likewise to physical properties, and would, therefore, include physical signs.

Vital symptoms are often less confined to a part than physical signs; because the vital properties of the whole system are in general connection; thus the irritability of the heart spreads its influence throughout the vascular system, the sensibility of one part affects the nervous centres, and may produce sympathetic symptoms in other parts, (§ 156;) disordered secretion has effects on other parts, (§ 162—7, &c.;) so that vital symptoms are often generally distributed throughout the body. For this reason, they have been sometimes called *general* symptoms, to distinguish them from physical signs, which are chiefly local; but this appellation is not exact, inasmuch as vital symptoms are sometimes entirely local: as in the case of pain, spasm, &c.; and we have already mentioned, that physical signs are sometimes quite general throughout the body, as those of the yellowness of the whole surface in jaundice, the swelling of the body in dropsy, &c.

Vital symptoms are sometimes called *rational*, because (I presume) their connection with their cause is rather a matter of inference than of direct observation: but this is the most absurd term of all; for observation is necessary to teach us the value as much of symptoms as of physical signs; and physical signs are of little use without a proper exercise of reason upon them.

607. Vital symptoms may be exemplified in pain, uneasiness, altered and impaired sensations, which arise respectively from exalted, perverted, or defective sensibility, (§ 125—136;) in spasm and paralysis, which proceed from excessive or defective contractility, (§ 110—118,) or excitomotory power, (§ 139—154;) in cough, which is caused by irritation or undue excitability of the excitomotory nerves of the air-passages and muscles of expiration; in vomiting, which depends on irritation or undue excitability of the stomach and the excitomotory nerves sympathetically allied with it; in dyspnœa, which arises from a feeling of want of breath, (§ 234;) in fever, which comprises an accelerated pulse, hot skin, diminished secretions, &c. (§ 437.)

Symptoms may further be found in the state of the different bodily functions in which vital properties are concerned. Thus the state of the pulse is an important source of symptoms: a frequent or a slow pulse indicates an increased or deficient excitement or irritability of the heart, (§ 113, 117;) a strong or weak pulse implies an increased or diminished strength of the heart's contractions, (§ 112, 116.) A hard or sharp pulse is in part dependent on an increased tonicity of the arteries, (§ 121;) whilst a soft, compressible, or liquid pulse, depends on a diminution of this property, (§ 123.) Irregularity in the rhythm of the pulse arises from an alteration in the vital property of irritability in the heart, commonly connected with loss of strength. These various conditions of the pulse are sometimes the result of various diseases directly affecting the vital properties of the heart and arteries themselves; but more commonly they are induced by diseases of other parts, sympathetically or through the blood influencing these organs, as in inflammatory fever, (§ 437.) Thus, in diseases of the heart and arteries, the pulse has more of the character of a physical sign; whilst in other disorders, it is rather a vital symptom, depending on further vital properties.

The state of the skin is another source of symptoms chiefly connected with the vital properties of the superficial vessels and secernent apparatus, and of the general circulation. Thus the heat and dryness of the skin in fever arise from accelerated circulation with diminished perspiration. When the skin is cold, the circulation is weak; when warm, it is active; and the occasional occurrence of perspiration in both these conditions shows that another vital property, that of secretion, is concerned in causing the symptoms, dryness and moisture of the skin. The signs furnished by the skin are physical, so far as regards the condition of the skin itself; but they are vital symptoms in relation to the state of the circulation, of distant organs, or of the system at large.

Many important symptoms may be derived from the appearances of the tongue. These appearances, when arising from primary disease in the tongue itself, may be considered as physical signs of its condition. Thus, when the tongue is inflamed, it is first red and swollen, and afterwards becomes covered with a film of fur, which, separating in patches, leaves the surface red, and smoother than before. But in a great many diseases, the tongue becomes red, swollen, furred, or brown and dry, from causes acting through the system; and these secondary affections of the tongue constitute symptoms of these diseases. The connection between febrile and other general diseases, and the appearances which they produce in the tongue, is not well understood; but it probably depends on changes in the secretion of the mucous membrane covering the tongue and adjoining parts.

[The state of the tongue has always attracted attention; and although the importance of the signs which it furnishes have been exaggerated, they are interesting and valuable. The tongue in disease is to be studied in connection with its modifications in volume, form, movements, colour, degree of moisture, nature of its coatings, its temperature and sensibility. Diminution in the size of the tongue is a frequent symptom in typhus and other low fevers; it is at the same time generally trembling and dry, conditions of equal gravity. A pointed, conical tongue was once supposed sufficient to establish the existence of gastritis. Experience has shown, however, that it indicates neither the nature nor the seat of the disease, or its danger, and that it depends entirely on the manner of contraction of the muscles of the organ. Impeded movement and distortion are valuable as unfavourable signs in fevers as well as in cerebral disease. In paralysis the deviation is usually more apparent than real; its seat being the buccal commissure and not the tongue. When the tongue presents on its upper surface a coating, it is generally evidence of some morbid condition. Fasting will, in some persons, produce a white fur, and others who sleep with their mouth open are liable on waking, to have the tongue dry and dirty. Does the tongue faithfully represent the state of the stomach? The result of careful and repeated observations on the part of Dr. Louis indicate on the contrary, a great degree of independence of the conditions of the tongue and stomach. His observations, confirmed by others, show that the aspect of the tongue bears no relation whatever to that of the stomach; the same state which coincides at one time with decided disease of the stomach, occurs at others where this organ is healthy. Albuminous exudation on the surface of the tongue is unconnected with any particular state of the stomach, but is a phenomenon of singularly bad augury, as it rarely appears until a few days before death. It occurred in one-eighth of the cases of phthisis observed by Dr. Louis.—C.]

The alvine excretions furnish symptoms of great importance in various diseases. When excessive in quantity, liquidity, and frequency, they constitute diarrhœa, which may be primary—that is, a disease in itself, (§ 374;) or secondary, and, therefore, a symptom of disease, as in cholera and mucous enteritis. As a symptom, it presents further varieties in its character, whether fæculent, bilious, mucous, watery, &c.; and these varieties indicate respectively, accumulation of fæces, or excessive secretion of bile, mucus, or watery fluid, in the intestines. The opposite condition, that of costiveness, is also a disease itself, and an important symptom in many diseases, indicating defective peristaltic action, defective secretions, or both, in the intestinal tube. The quality of the evacuation supplies symptoms in regard to colour, shape, odour, &c., which often lead to a knowledge of the nature of disorder in the alimentary canal or in the system. Thus clay-coloured fæces indicate defective secretion from the liver; those very dark in colour may denote the presence of diseased bile or altered blood; vermiform motions may indicate stricture or con traction of the intestines; and so forth.

The urinary excretion is a valuable source of symptoms, not only of diseases of the parts connected with it, but of disorders of other organs, and of the whole system. Being the chief emunctory through which foreign, effete, and superfluous matters are eliminated from the blood, (§ 254,) it is continually exhibiting changes in quantity and quality, in colour and specific gravity, in its sediments, and in the effect on it of different chemical re-agents. All these changes furnish symptoms of disease, several of which have been already noticed in connection with various pathological elements, (§ 167, 176, 249, 254, 255, 257, 260, 309, 384, 385, 448, &c.)

608. The foregoing examples of sources of symptoms are given merely to illustrate where and how symptoms are to be sought for; to complete the list, it would be necessary to notice every function of every part of the body, and the symptoms which they furnish, which would fill a considerable volume.

As a knowledge of the mechanism of organs, in health and in disease, and of the physical laws which operate in them, is the best aid to the study of physical signs, so an accurate acquaintance with the structure and functions of the healthy and diseased body, and with the vital laws which influence them, is the best guide to the knowledge and explanation of vital symptoms. These symptoms are often obscure and unintelligible; because physiology and pathology is imperfect; but in proportion as these sciences are advanced, their application to semeiology and diagnosis will be more complete. In the meantime, much of our knowledge of symptoms rests chiefly on mere experience; and until the results of experience can be arranged in a more scientific manner, they may be parcelled *numerically*, in order to approach their laws by empirical means. But to render this *statistical* or *numerical* method of studying symptoms at all safe, it is necessary that the numbers of observations should be very large, that they should be applied to similar cases, and that the majorities which establish the rule should very greatly preponderate over the exceptions.

609. Physical signs and vital symptoms respectively have their value in making known the nature and extent of disease. Physical signs are more certain, because they appeal more directly from the seat of disease to the senses; depending on simpler and more constant causes, physical properties, they are more constant, and less subject to variation than vital symptoms, which result from more complex, and therefore more variable, vital properties. Thus of the signs of inflammation, the redness, heat, and swelling, are physical signs, and more certainly prove the existence of inflammation than does pain, which is a symptom depending on the vital property, sensibility, and which may be present where inflammation does not exist, (§ 136;) and may fail to occur when inflammation is present, (§ 433.) The physical signs of a structural disease in the lungs or heart are better evidence of its existence, and of its nature, than cough, dyspnœa, pain, palpitation, &c.; because we know that these symptoms may arise from merely nervous or other causes, without the presence of any alteration of structure. Yet vital symptoms, although less sure and constant than physical signs, are often more delicate, being present before physical changes become appreciable; and when they coexist with physical signs, they indicate the nature and amount

of disorder of the vital properties of the part, and of the whole system. Thus feelings of chilliness and discomfort, which usher in the fever accompanying tonsillitis, are sometimes present before the throat exhibits the physical signs of inflammation. A slight cough is often present in the early stage of phthisis, before the physical signs of tubercles can be distinguished. Crepitation heard in the posterior regions of the chest is a physical sign of engorgement of the lung with liquid in the minute tubes; but we must refer to the vital symptoms to determine whether the engorgement is inflammatory or only congestive. The physical signs of consolidation of the lung, and of valvular disease of the heart, are very distinct; but in order to determine whether these affections have arisen from present or recent inflammation, or are the results of old disease, it is necessary to consult the vital symptoms; and this determination is of great importance to the prognosis and treatment.

In short, it is obvious that both classes of signs ought to be carefully taken into account; and the more fully the physical and vital properties which constitute them are understood, the more available will signs and symptoms be to instruct us as to the nature and treatment of disease.

610. Besides into physical and vital, various divisions of symptoms have been made; but they are of little real utility, and it is unnecessary to do more than enumerate them. Symptoms are *local*, or *general*, or *constitutional*, according to whether they are confined to the diseased part, or affect more or less the whole system. Symptoms are *idiopathic*, when directly proceeding from a primary disease; they are *sympathetic*, or *secondary*, when arising from secondary disorders, or those produced by the primary disease. *Premonitory* or *precursory* symptoms are those which precede the full development of disease, and commonly result from the first operation of its cause; hence they are called *symptomata causæ*. *Commemorative* symptoms are those developed in the previous history of the disease. *Anamnæstic* are those which relate to the previous state of health. Signs have been divided into *objective*, those which present themselves to the scrutiny of the practitioner; and the *subjective*, those described by the patient himself. The objective have been further divided into the *active* or *dynamical*, those that require some action or motion of the patient to discover them; and the *passive* or *statical*, those which are obvious without such action. Symptoms are designated by the epithets, *diagnostic*, *prognostic*, and *therapeutic*, when they are specially applicable respectively to the distinction, the determination of the event, and the suggestion of the treatment of disease. Symptoms are *positive*, when they consist of phenomena actually present; *negative*, when they consist in

the absence of phenomena. Of diagnostic symptoms, those are called *pathognomonic* or *pathognostic*, which are peculiar to one disease. A single symptom or sign is rarely, if ever, pathognomonic; but two or three taken together often are so.

611. The *diagnosis* of diseases is the distinction of diseases from one another. It may relate to diseases in their essential nature or pathology, or to those groups of symptoms that are classed as separate diseases by nosological arrangements, (§ 597.) In other words, the object of diagnosis is, to determine either the intimate nature and seat of a disease, or its name and place in a classification of phenomena grouped under the name of special diseases. According to the nosological arrangement which has been recommended as the best at present, (§ 600,) the division into special diseases is, as much as is practicable, founded on pathology, or the essential nature of disease; and diagnosis should also have a corresponding reference to this subject. But as it has been admitted that pathology is not sufficiently advanced to be the sole basis of nosology, so we must avail ourselves of other sources of information in regard to diagnosis. Accordingly, much of the materials of diagnosis are the results of simple observation or clinical experience; and where these cannot be analyzed by any more rational mode, they may be measured or valued by *the numercial method*, or counting and calculating the results in a large number of cases. Thus diagnosis is chiefly derived from semeiology, and the results of clinical experience, arranged by pathology and statistics. In some instances, the causes and the treatment of disease give aid in the diagnosis. Thus the malarious character of a patient's residence, and the efficacy of quinine in curing him, will contribute important evidence as to the nature of his disease.

612. Diagnosis may be *general* or *special*. *General* diagnosis comprehends the distinction between the principles or elements of disease, (§ 104;) as, for example, between congestion and inflammation; between nervous irritation and structural disease, &c. This is properly a branch of general pathology; and if time had permitted, would have been introduced here. *Special* diagnosis relates to the distinction of diseases according to their chief seat, where they have one, (§ 599,) or according to some other specific difference, where they have no particular head-quarters. Thus the special diagnosis of inflammations is between inflammation of the parenchyma of an organ and that of its investing membrane; or between an intermittent and a continued fever. Special diagnosis also follows and distinguishes diseases in their further differences of seat or character; as the part or extent of a parenchyma or membrane inflamed, the type of a fever, &c.

Thus special diagnosis is a branch of special pathology, and should be aided by an accurate and practical nosological arrangement. The mode of distinguishing between two diseases which resemble each other has been absurdly called *differential diagnosis.* It consists in pointing out the signs which are essential to the one and not to the other. The signs called pathognomonic, where they exist, are the chief guides in differential diagnosis.

613. The modes of investigating and distinguishing diseases will vary much in different cases, according to the class of symptoms that first present themselves. This may be illustrated by the following problems:—

General pathology having pointed out the general nature of a disease, it is required to determine its precise seat. *Example.* In a case in which fever, hard pulse, buffed blood, and local pain indicate inflammation, the seat of the inflammation is determined by the chief place of pain or uneasiness, (in the chest or side,) by the function most disturbed, (difficult breathing and cough,) to be in the organs of respiration; by the secretion proceeding from the part, (rusty, viscid expectoration,) and from the physical signs, (impaired breath-sound and stroke-sound in part of the chest, with crepitant rhonchus,) to be in the parenchyma of the lungs; that is pneumonia. General pathology here commences the diagnosis, which is completed by reference to symptoms explained by physiology and special pathology.

Previous history, prominent symptoms, or physical signs, having pointed out the seat of a disease, it is required to determine its nature. *Example.* A person suffers from severe pain at the epigastrium; the previous occurrence of symptoms of indigestion, and the situation of the pain, plainly show the disorder to be seated in the stomach; the nature of the disease (whether nervous or inflammatory, &c.) is to be determined by general pathology; guided by this, and finding an absence of symptoms of inflammation, no increased heat of surface, no acceleration of the pulse further than what the pain would cause, and no increase of the pain on the imbibition of warm or stimulating liquids; and finding symptoms of predominant nervous properties, and the sudden attack, intense character, and transient duration of the pain, which distinguish nervous and spasmodic affections, we decide that the disease is gastralgia or gastrodynia, and not gastritis. The diagnosis which is begun by local symptoms is completed by reference to the principles of pathology.

Lastly, which is a common case, symptoms being too few or too inconclusive to declare the diagnosis, both the seat and the nature of the disease are to be determined. *Example.* A person complains of general uneasiness, weakness, and chilliness, with various functional symptoms, but none of a prominent character.

Clinical experience has taught the practitioner that such are the symptoms of incipient fever; and he proceeds to investigate further the nature and cause of the fever. If he finds, on close examination of the functions and physical condition of the different organs, that one is the seat of marked inflammation, and that the fever is not typhoid, he judges that the fever is symptomatic of the inflammation; but if signs of marked local inflammation be absent, yet the fever continues with increasing symptoms of depression, weak frequent pulse, brown dry tongue, sordes on the teeth, low delirium, &c., he recognizes typhoid fever, resulting from the influence of a morbid poison on the system, (§ 105.)

614. Thus, every department of medical knowledge is brought to bear on diagnosis; and in no branch is the information, as well as the judgment, of the practitioner more brought to a test. Natural shrewdness and tact, with some general knowledge of the nature and treatment of disease, may sometimes enable a comparatively ignorant person to practise medicine with an appearance of success; but such a person can make no hand of diagnosis; and he wisely either evades the whole subject or expresses his opinions in vague terms, and scrupulously avoids their being brought to the test of the scalpel. The well-informed practitioner, on the other hand, feels that this is the subject which requires the full application of his mental powers and knowledge, as well as the keen exercise of his powers of observation; and in proportion as his senses are practised in observing, his information well arranged in relation to what he observes, and his judgment matured in discriminating and deciding the results, so will he be successful in forming his diagnosis, and in applying it to prognosis and practice.

615. In investigating the symptoms of a case with a view to diagnosis, prognosis, and treatment, the observation is first drawn to those which at once declare themselves in the *aspect* of the patient, the expression of the countenance, the complexion, the posture, the manner of the movements, speech, &c.; and these give important information to the observing practitioner at first sight and whilst he is interrogating the patient. After the first few statements of complaints, which are generally volunteered by the patient, the questions should be directed to the *history* of the ailment, including the *previous state of health and habits*, with regard to food, clothing, occupation, residence, &c., any former illness, *the mode of the present attack*, and its *supposed cause*, the *former symptoms*, and treatment, if any has been employed. The answers to these questions will direct the inquiries in the most searching manner with regard to the *present state* and *symptoms*. The mode of investigating these will partly depend on the clue given by the answers to previous questions;

but the practitioner must not permit himself to be so far led by the patient's statements as to omit to examine the state of all the important organs and their functions. The *nervous system and its functions*, (sensorial, sentient, excitomotory, and sympathetic;) *the organs of circulation and their functions*, (pulse of heart and arteries, capillary circulation of surface and visible parts, temperature, state of veins, &c.;) *the organs of respiration and their functions*, (breathing, cough, expectoration, voice, arterialization of the blood;) *the organs of digestion and their functions*, (tongue, appetite, digestion, &c.;) *the organs of secretion and excretion and their functions*, (liver and intestines, kidneys, bladder, and the skin;) *the functions of nutrition and assimilation*, (to be judged of by the condition of the flesh and comparative weight of the body;) *the organs of locomotion and their functions; the organs of generation and their functions;* are severally to be made the subjects of inquiry and physical examination to such an extent as may be requisite to inform the practitioner of their true condition and connection with the past or present disease.

The object of a complete investigation of the state of the patient is not merely to determine the particular disease under which the patient labours, but to discover what is healthy as well as what is morbid in his condition. The prognosis, or estimation of the amount and event of the disease, and the application of treatment, requires this full investigation. We have to consider, not merely *disease in the body*, but *the body in disease;* and it is by losing sight of this great practical axiom, that minute or microscopic inquirers, who may be singularly successful in special diagnosis, signally fail in prognosis and in practice.

CHAPTER VI.

PROGNOSIS—FOREKNOWLEDGE OF THE RESULTS OF DISEASE.

616. PROGNOSIS is that knowledge by which we are enabled to foresee the course, duration, and event of a disease. Like the treatment of disease, it may be either *empirical* or *rational.*

Empirical prognosis is that which is founded on experience or observation only, without regard to the nature of the disease or the reasons which determine the results. It consists in the observation of the *good* and *bad* symptoms—that is, those symptoms which have, in a great majority of cases, been followed respectively by a good or a bad result. This mode of prognosticating the events of disease was the only one attainable in the early ages of medicine. The "prognostics" of Hippocrates chiefly consisted in the enumeration of good and bad signs; and the frequent truth of the distinctions which he has made on these points show the extent and accuracy of his observation or of the sources from which his information was drawn. In a limited sense, the same faculty of empirical prognosis is often acquired by nurses or other non-medical attendants of the sick. These can often tell when a patient is getting better or worse, by the appearance of the countenance, the state of the voice, the mind, the strength, the breathing, the excretions, &c., whilst they may be in total ignorance of the nature of the disease and why the signs are good or bad. This kind of prognostic knowledge, although it may be useful in enabling a person to pronounce a patient better or worse, falls far short of that which ought to be expected of the scientific practitioner, who should not only have a greater number of prognostic symptoms within his reach, but should be able to foresee them, so as to anticipate, and, if possible, to influence them in a favourable manner.

617. *Rational prognosis* is the estimation of the importance and tendencies of a disease from a knowledge of its causes, its true nature and symptoms, and of the power of treatment in regard to it. Like rational diagnosis, (§ 614,) it derives its evidence from all available sources, and makes the best use of this

evidence by analyzing it, and thus determining its value. Thus, in the early stage of inflammation of the lung, the discovery of the nature and seat of the affection at once shows the presence of a serious disease, whatever may be the state of the present symptoms. The practitioner, in forming a rational prognosis, takes into account the extent of the inflammation, knowing, from experience as well as from reason, that this is a source of danger: he considers the duration of the attack, and from the signs and symptoms judges whether it is increasing or not. These considerations may give him some insight into the severity of the disease, but his prognosis is to be determined by further conditions. He knows, by experience and reason, that inflammation of the lungs, although always a dangerous disease, becomes much less so when it is at a stage and in a subject in which antiphlogistic remedies can be well borne: thus, at an early stage, in a young and vigorous subject, even the most extensive inflammation may be cured by blood-letting and other means judiciously employed; but if the disease has advanced far, and the function of respiration has been for some days impaired by it; if the subject be feeble, from infancy, or from extreme age, or from previous disease, from intemperate habits, from a complicating disorder, or from any other cause, the prognosis becomes more unfavourable, inasmuch as there is little power in the system to bear the appropriate remedies, or to withstand the evil effects of the disease.

To take an example of another disease. In continued fever, certain symptoms have been found by experience to be of an unfavourable character. The pathological practitioner profits by this experience, but he analyzes the results and goes further. He knows that the appearance of petechiæ, congested face, and stupor, at the commencement of fever, are bad symptoms, but that they are so mainly in proportion as they arise from the changed state of the blood induced by the depressing cause of the fever; and when, as it sometimes happens, these symptoms appear without any corresponding depression of the heart's power, as manifest by extreme frequency and weakness of the pulse, they are by no means of such unfavourable import, but may arise from the plethora of the subject. Again; symptoms referable to the excitomotory system, (§ 153,)—such as subsultus, hiccup, and convulsive affections,—are generally unfavourable in continued fever; but they are so only when arising from the severe operation of the cause of the fever on the nervous centres; they are much less so when occurring in a nervous subject, in whom slight causes may induce them. The same remark may be made of a state of stupor, which would be of most serious import if dependent on fever alone; but it may be induced by slight fever, or other cause, in an hysterical subject. The pathologist is prepared for these differences, and can qualify his prognosis accordingly. He can trace the danger of bad symptoms, beyond the symptoms themselves, to those interferences with vital functions which renders these symptoms dangerous, and of which these symptoms are not always the true exponents.

618. As our limits do not admit of details, it must suffice to enumerate the chief circumstances from which a rational prognosis may be formed, with illustrative examples.

The cause of the disease.—Epidemic, endemic, and infectious disorders, are chiefly serious in proportion to the intensity of their cause. Thus the endemic of a hot climate is more dangerous than that of a cold climate: an infectious disorder propagated in close habitations is more severe, from the concentration of its cause, than one arising from more diluted infection. By knowing the source of the disease, some estimate may be formed of its future severity.

519. *The age of the subject.*—Acute diseases are ill borne at either extreme of age. Acute diseases are most common in young and middle age. In old age, the tendency is to more chronic maladies.

[In early infancy there is always hope, even with the most dangerous symptoms. "*L'enfance est l'age des resurrections,*" says Chomel. It is at this period of life that the well-known adage *ubi vita, ibi spes*, is so applicable. In old age, on the contrary, acute diseases which assume a severe form almost always terminate fatally. In middle age the chances are more favourable, and are greatest in youth and adolescence. The exceptions to this rule are the eruptive fevers, which are less dangerous in infancy, and certain organic affections, which are said to advance less rapidly in old age.—C.]

The sex of the patient.—Nervous diseases are most common and obstinate in the female sex; but they are more serious in the male sex. The occurrence of the catamenia is often favourable, as their suppression is unfavourable in the course of a disease.

The temperament of the patient.—In the sanguine temperament disorders are apt to be acute; in the phlegmatic temperament, more chronic; and in the nervous temperament, more changeable.

Previous diseases of the patient.—The same disease having occurred before, prevents or renders slight a subsequent attack, in the case of eruptive fevers, hooping-cough, &c.; but increases the tendency and the danger in case of apoplexy and most structural diseases. Albuminuria and dropsy are more curable, when ensuing after scarlatina, than when after other causes; but rheumatism, after scarlatina and gonorrhœa, is often unusually severe and intractable.

Present diseases of the patient.—These generally increase the severity or intractability of the new disorder, especially if they be structural. Thus infectious disorders and fevers are peculiarly fatal in persons with diseased heart, lungs, kidneys, or brain. Yet moderate hypertrophy of the heart is rather a favourable circumstance in phthisis. Cutaneous and some other external diseases sometimes suspend attacks of gout, gravel, diarrhœa, &c.

Previous habits of the patient.—Intemperance and excesses of all kinds enhance the danger of all serious attacks. Extreme privations, or over-fatiguing employments, make persons liable to fevers and other depressing diseases, and reduce the powers of reaction against them.

Condition of the patient at the time of the attack.—Extreme weakness or exhaustion from any cause renders persons *bad subjects* for most diseases. Plethora increases the intensity of inflammatory affections. [This statement has been shown to be incorrect.—C.]

[Pregnancy increases the danger of a disease supervening during its progress. Inflammations of the organs, and of their investing membranes, are very apt to pass into suppuration, and the exanthemata, under similar circumstances, are liable to be attended with ataxic and adynamic symptoms. Diseases occurring in the course of pregnancy are more severe and dangerous in proportion as they approach the period of confinement.—C.]

620. *The situation and nature of the disease.*—The more important to life is the part attacked, and the more the disease interferes with its function, the more dangerous will it be. Thus the heart, the lungs, the medulla of the nervous system, and the blood, cannot be extensively attacked without great danger to life; and if the disease goes on to affect structure, as inflammation, the danger is prolonged in proportion.

The extent and progress of the disease.—The greater the extent of the disease, the more serious it will be in case of inflammation; but the severity of the symptoms is often not in proportion to its extent: intense and circumscribed inflammation causing more prominent symptoms than that which is extensive and diffused. The progress of disease most materially influences its effect on life and health. Thus the structure of the lungs, heart, kidneys, or liver, may become diseased to a most extraordinary amount, without destroying life, if the advance of the lesion is very gradual; whilst a third or fourth of the same mischief would prove fatal, if it were induced suddenly.

621. *The character of the symptoms.*—This is exhibited in the details of each disease. Those symptoms augur favourably which show a power of moderate and regular reaction, and a return of the functions to their natural state. The removal or

alleviation of the more distressing symptoms of disease—the restoration of the natural appetites, and feelings, bodily and mental—the return of strength—the disposition to sleeping tranquilly, and waking at the usual times—secretions that have been interrupted or diminished being restored, and often in increased quantity, as if from accumulation, as in the case of *critical* perspirations, deposits in the urine, &c., (§ 448,)—are among the chief signs of approaching recovery.

[A brief sketch of some of the most common symptoms influencing our prognosis, will not, perhaps, be here without value.

Much may be inferred from the general aspect of the patient. Constant change of position, unimportant in the beginning of acute diseases, becomes alarming when it persists for any time. Lying continually in the same position, as constant dorsal decubitus, in low forms of disease, is a very bad symptom. Inability to lie down, which sometimes happens in thoracic disease, is equally sinister. Jactitation succeeding to quietude, in the latter stage of acute disorders, is generally a mortal sign, especially when accompanied by an attempt to throw aside the bed-clothes, and ineffectual efforts to rise.

Progressive emaciation in acute affections is of little importance, but in chronic disorders it should lead us to anticipate a fatal termination in proportion to its rapidity. General œdema is of extremely bad augury. The occurrence of sloughs in various parts of the body, in both chronic and acute disorders, is a very bad sign. The physiognomy should be especially studied in reference to prognosis. When the natural expression of the countenance is preserved, it is always of favourable import. Great alteration in the features in the commencement of an acute disorder, ought to make us fear, about the fifth or ninth day, the supervention of low symptoms. In the advanced stage of all diseases, a sudden and great alteration in the physiognomy, announces approaching dissolution. When it occurs at a period where a fatal termination is not to be anticipated, it should lead us to suspect the development of some acute affection, the enfeebled state of the patient not admitting of its exhibiting the ordinary local symptoms; a sudden aggravation of the general symptoms being the only indication. It generally announces death in less than three days. This change of countenance must not be confounded with the pallor which marks the commencement of convalescence in fever, etc.; the accompanying phenomena serve to distinguish them. Subsultus, trembling, and rigidity always mark danger. Carphologia, epileptic and tetanic convulsions, rigidity of the limbs, are mortal signs in the advanced stages of fever. Another invariably fatal symptom, according to Chomel, is the automatic movement by which the patient seeks to approach his hand to his body, whilst the physician is feeling his pulse. Aphonia is a bad sign in acute disorders. The intensity of pain, by no means, in general, indicates the amount of danger. *Cæteris paribus*, deep-seated pain is more unfavourable than that which is superficial; and that which is fixed more so than that which is variable. The sudden cessation of pain in inflammation, joined to great alteration in the features, indicates approaching death. According to Chomel, suppuration not gangrene will be found, under such circumstances, on examination. Deafness is a sympathetic phenomenon occurring in many acute diseases, and is always serious. In the mortality of typhoid fever, if a comparison be made of those who suffered from deafness in the course of the disease and those who did not, the deaths among the former will be found as two to one among the latter. (Chomel.) Hope and cheerfulness are generally good signs. Distrust and despair are very unfavourable symptoms. It is rarely that patients who have the persuasion that they will die, recover, unless they are hypochondriacs. Total indifference is a bad sign. In several chronic disorders, the tranquil security enjoyed by patients does not diminish the gravity of the prognosis.

The prognostic signs furnished by delirium are connected with its intensity, persistence, and the conditions under which it occurs. Mild delirium, soon passing off, is not serious; permanent delirium always is. Many persons, of all ages, are liable to delirium whenever they are attacked with ephemeral fever, or an angina; it is only necessary to be aware of the idiosyncrasy in order to appreciate the value of the symptom.

Prolonged sleep in the course of fevers is not dangerous if the patient can be readily aroused. Coma is alarming and nearly always mortal when intense and permanent.

The sudden occurrence of a voracious appetite announces speedy death, (Baglivi.) Chomel has frequently met with this symptom in pneumonia; death soon took place. Dysphagia is generally a mortal symptom in cerebral and acute disorders.

The signs which the respiration furnishes prognosis are important and rarely deceive. A hurried respiration indicates great danger. When the number of respirations amounts to fifty in the minute, it may be generally stated that death will soon follow. The tracheal rattle and stertorous breathing are usually precursors of dissolution, especially when they occur towards the latter stages of cerebral disease. In inflammation of the lung stertor is not alarming so long as expectoration takes place. Paroxysmal is less dangerous than permanent dyspnœa. Hiccough is a very unfavourable symptom in the latter stages of disease, unless it is accompanied by a notable amendment in the other symptoms.

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The pulse furnishes few but important symptoms. A pulse of moderate frequency and force is favourable. Considerable frequency of pulse indicates something serious. A pulse of 150 in an adult should lead to a very unfavourable prognosis. If at an advanced period of any affection the pulse becomes irregular or intermittent, or ceases, death is near.

Augmentation of the heat of the body is of bad import, especially when dry. Sudden chilliness of the extremities and rest of the body occurs usually a short time previous to dissolution. Chills at an advanced period of the disease, should lead to the suspicion of the formation of pus, or of its resorption, according to circumstances. Abundant sweating towards the close of a disease is a favourable sign. Cold sweats at the same period are generally unfavourable.

Hæmorrhages at the beginning indicate usually that the disorder will be serious. Towards the close they are either favourable or unfavourable. Epistaxis, the hæmorrhoidal flux, and metorrhagia, are generally favourable signs in those who are liable to them. Hæmorrhages from the lungs and intestines are usually mortal; those from the urinary organs nearly constantly fatal.

The degree of strength which the patient possesses is of great importance in forming a prognosis; considerable diminution or perversion is always dangerous, especially in the early stage of the disease.—C.]

622. Bad or unfavourable symptoms are those which arise from such an impediment of one or more of the functions more immediately concerned in the sustenance of life, the circulation of the blood, respiration, nutrition, and excretion. In proportion as these functions are speedily and considerably impaired, life is threatened, and there is an approach to its destruction, by one or other of those terminations, which are called *modes of death*. Thus there is death by *syncope*—cessation of the circulation; by *asphyxia*, or *apnœa*—interruption of the respiration; and by *inanition*. To these may be added, death by the *pernicious influence of excrementitious matters*, and by poisons, which cause death in various modes. These different modes of death are more distinct when induced so speedily as to leave the functions, which they do not directly affect, comparatively vigorous and outliving that which has been chiefly injured. Thus, in sudden death from causes stopping the respiration, the heart continues to act for some time, until the death which has begun with the breathing function reaches it also.

623. If we further trace the operation of these different modes of death, we shall find that they all agree in affecting the blood,

either by altering its composition, or by arresting its circulation; and it is through one of these means that death extends to all the functions. Thus in death by cessation of the heart's action, the circulation is at once arrested; hence this is the most speedy mode of death. Inanition obviously operates by reducing the circulating material, and by further weakening the organs by which the circulation is carried on. Asphyxia we have already found (§ 235) both to impede the circulation and to alter the condition of the blood. Excrementitious matter retained in the blood, and extraneous poisons, also operate in various ways: by impairing the irritability of the heart; or by injuring the medullary nervous function, (§ 154,) on which respiration depends; or by arresting the passage of the blood through the capillaries, (§ 298;) or (and this probably includes some of the former modes) by so changing the properties of the blood itself, as to render it unfit for its office of sustaining the life of the functions; and the operation of all poisons, as well as of other causes of death, may thus be traced to defective circulation or composition of the blood. It is the more necessary to keep these points in recollection, because they show why death from disease often takes place without distinctly beginning with any set of functions; but all fail from want of proper blood, their natural support.

624. It will be useful to mention the chief varieties of the modes of death above noticed, and to state their symptoms, which may become available as prognostic signs of the approach of death.

Death (cessation of function)	beginning at the heart	Sudden=syncope. Gradual=asthenia.
—	—	beginning at the breathing apparatus=Asphyxia or apnœa.
—	—	beginning at the brain=Coma.
—	—	beginning at the medulla=Paralysis.
—	—	beginning in the blood=Necræmia (νεκρος, *dead;* αιμα *blood.*)

625. Death by *cardiac syncope*, or sudden cessation of the heart's action, may occur in two ways—1. By this muscle losing its irritability, (§ 116,) so that it ceases to contract; and 2. By its being affected with tonic spasm, (§ 114,) in which it remains rigidly contracted, losing its usual alternation of relaxation. In both these cases, death is quite instantaneous: the subject suddenly turning pale, falling back or dropping down, and expiring with one gasp. In the first case, both sides of the heart are found, after death, distended with blood; and if the examination were made soon after death, the blood in the left cavities would be found to be florid. In the second case, the heart appears small and very hard; the ventricles (or at least the left) are found so firmly contracted, that the cavity is almost obliterated, and con-

tains no blood; the muscle is very firm; but after maceration in water, or even without it, in two or three days, the walls of the ventricle yield to the pressure of the fingers, and the cavities may be restored to their normal dimensions. This state of the heart was long mistaken for concentric hypertrophy, until Cruveilhier and Dr. G. Budd pointed out its true nature.

Although syncope by loss of irritability, (paralysis,) and syncope by spasm, appear to be opposite states, yet they arise from somewhat similar causes. In animals, wounds of the heart are followed sometimes by the one, sometimes by the other. Death by *shock*, as from tearing off a limb, a violent blow on the epigastrium, crushing the brain or spinal marrow, is sometimes caused by spasm, although more frequently by paralysis of the heart. In sudden death from drinking a quantity of raw spirits, or of very cold water when the body is heated, the heart has been found contracted.

Syncope by loss of irritability of the heart is the more common case; and, besides in the examples above given, it may be induced by the operation of large doses of certain poisons called sedative —such as the upas antiar, infusion of tobacco, and digitalis; and in combination with other effects, by large doses of hydrocyanic acid, strychnia, oxalic acid, arsenic, preparations of baryta, and various animal poisons. Mr. Blake found the power of the heart destroyed by solutions of various saline matters injected into the veins, especially salts of potass, magnesia, zinc, copper, lime, baryta, and lead; but these results do not correspond with what we find of the operation of these substances when introduced into the stomach.

The diseases in which death by cardiac syncope sometimes takes place are—those of the heart, (but more rarely than is commonly supposed;) hæmorrhagic apoplexy, attended with much injury to the substance of the brain, (§ 364;) anæmia, (§ 270;) and adynamic fevers, (§ 105.) As it occurs suddenly, there can scarcely be said to be symptoms; but sometimes an approach to it has been manifested in previous attacks of common syncope or faintness, in which the action of the heart becomes weak, irregular, and intermittent; and the partial failure of the circulation is evinced in the paleness of the face, lips, and general surface, often with cold perspiration; the failure of the sensorial functions, (*defectio animi*,) loss of consciousness and volition more or less complete, sometimes attended with various convulsive movements, (§ 153, 265;) the eyes turning up or becoming fixed or glazed, and the pupils dilated. The different effects of posture on the form of syncope have been before noticed, (§ 70;) and they may be presented in cases in which cardiac syncope ultimately proves fatal. The recovery from this faintness is often attended with shivering, vomiting, sighing, gasping, yawning, and various distressing sensations of noises in the head, flashes in the eyes, palpitation, depression of spirits, &c.; whilst the pulse regains its strength and regularity, and the colour and warmth return to the surface. After this may ensue a reaction, like that which occurs after great losses of blood, (§ 266, 362.)

626. Death by the *gradual cessation of the heart's action* has been termed *asthenia*, (α, not, σθενος, strength.) This is the mode of termination of many diseases, especially those which destroy life by exhausting the strength, without any direct interference with the more vital functions. Thus long-continued fevers, delirium tremens, gastritis, enteritis, peritonitis, hæmorrhages, and various discharges of animal fluids—such as diarrhœa, diabetes, extensive ulcers or abscesses, &c., proving gradually fatal—inanition from want of sufficient food, and several others, reduce the power of the heart, and with it the functions of the whole body, to a lower and lower state, until at last the heart flutters and dies.

The symptoms of the approach of death by asthenia are—increasing weakness of body and mind, whilst there may be no marked derangement of any particular function of either; increasing frequency, and diminishing strength of the pulse; the face, lips, and other parts of the surface, gradually become paler and paler, or of a death-like sallowness; the extremities lose their warmth, and often become œdematous; the appetite fails; the tongue becomes sometimes dry and brown, sometimes furred, and the mouth aphthous, (§ 483;) the excretions first are imperfectly voided; then the sphincters lose their power, (the weakness reaching their excitomotory function,) and involuntary discharges of urine and fæces may take place; and this state of *sinking* in a few hours terminates in death. The symptoms above described are those of progressive loss of power, not confined to the heart, but through its failure and that of the circulation of the blood, of which it is the chief instrument, becoming extended throughout the whole frame. But with this general debility there are often symptoms of partial excitement and reaction, which sometimes mark the sinking state. Thus a febrile excitement of a hectic kind (§ 471) may come on, giving slight temporary strength to the pulse, flush to the cheek, life to the eye, and a sort of flickering reanimation to the whole frame. Sometimes the excitement is of a more partial kind, affecting the brain, as with delirium; or the medulla, as with *subsultus tendinum*, hiccup, or other slight convulsion; or the stomach, as with vomiting, &c. Or in the sinking state, some functions may become obscured before others, in consequence of congestions, effusions, or even low inflammations occurring in the capillaries of some organs, (§ 290,) as the powers of the general circulation fail: thus the death by asthenia may become somewhat complicated with coma, from congestion or effusion within the head; or with dyspnœa, from congestion in the lungs; or somewhat similar symptoms may arise from the early failure of the excreting organs, and the retention of excrementitious matter in the blood, (§ 249.)

627. *Asphyxia* or *apnœa* has already been noticed as an element of disease, (§ 234,) and its nature and symptoms were then examined, (§ 235;) we here advert to it as a mode of death. By *death beginning at the breathing apparatus*, I mean that in which the function of this apparatus is the *first* to fail. In this respect, it is distinguished from death beginning at the brain or medulla, which destroys by *secondarily* suspending the function of breathing. Death by simple apnœa takes place in diseases of the lungs and air-tubes, in which the entrance of air to the lungs is impeded by effusion into the air-cells or tubes; or by pressure upon them, as in bronchitis, pneumonia, pleurisy, &c.; by obstruction to the passage of the air through the trachea or larynx, as in croup, laryngitis, and tumours or spasm constricting these tubes; or in circumstances mechanically excluding the passage of air by the mouth and nostrils, as in smothering, strangling, hanging, and drowning.

The symptoms of the approach of this mode of death are—increasing feeling of suffocation or want of breath, which becomes most distressing and agonizing as the want is unappeased; the efforts at respiration are made in a hurried and forced manner; the face, neck, and other parts of the surface become congested in proportion to the violence of these efforts; and as these efforts are unsuccessful, the colour of the congested parts changes from red to purple, and from purple to livid. The influence of this congestion and partial circulation of black blood (§ 235) is soon evident on the functions, causing stupor, reduction of temperature, weak and irregular pulse, rapid reduction of muscular strength, and consequently of the efforts to breathe. Hence the dark hue of the face may be changed for paleness; but the lividity of the lips, tongue, nails, and other coloured parts, remains until death. In cases of speedy death from violence, as hanging, drowning, &c., or from a sudden attack of laryngitis or spasm, the respiratory efforts are more vigorous, and the congestion and lividity of the surface are greater, and may remain until death. But in the slower asphyxia from diseases of the lungs and air-tubes, the interruption to the breathing is less complete, the efforts are less violent, the congestion of the surface is less marked, and the functions more gradually failing together, the symptoms peculiar to apnœa are less marked. Hence, too, as imperfectly arterialized blood is circulated throughout the body, it may cause peculiar symptoms, such as stupor and low delirium, partial paralysis, vomiting, relaxation of the sphincters, and other symptoms of sinking. This exemplifies what has been before remarked, (§ 622,) that the distinctness of each mode of death generally depends on its speedy supervention.

As prognostic signs, the symptoms of apnœa are more hopeless in proportion as they are conjoined with those of debility. The nature of the obstruction to the respiration must of necessity be taken into account; and if this be not complete and irremovable, the congestion and lividity of the surface are not fatal signs, so long as the strength of the breathing apparatus and of the heart does not decline; as this becomes exhausted the means of recovery are lost.

628. Death by *coma*, or beginning at the brain, is caused by various influences which primarily destroy the functions of the superior masses of the nervous system. The chief of these circumstances are—obstruction to the circulation through the brain by pressure, (as of effused blood, pus, lymph, or serum, or of distended vessels in apoplexy, a depressed portion of bone in fractured skull, &c.;) by coagula within the vessels, (§ 267;) by anæmia, (§ 267;) and by various narcotic poisons, such as opium, alcohol in large quantities, carbonic acid inhaled, (§ 246,) and sometimes the excrementitious matter of urine and of bile in the blood, (§ 249.)

The symptoms of coma are those of interrupted function of the brain, insensibility and suspension of voluntary motion, the heart's action not being materially impaired. These may come on in different modes. In apoplexy and injuries of the head they may supervene suddenly, and the patient at once becomes powerless and senseless, the pulse continues pretty good, although slower and fuller than usual, or it may be frequent from mere sympathy. In other cases, the stupor comes on gradually, and the senses and mental powers are often irregularly obscured, causing dimness of sight, appearances of clouds or cobwebs before the eyes, *muscæ volitantes;* various imperfections of hearing, with noises, or *tinnitus aurium;* numbness and tingling sensations in the limbs; loss of memory, confusion of ideas, hallucinations, low delirium alternated with stupor, (*typhomania,*) continued somnolency, &c. Partial paralysis often accompanies progressively advancing coma, sometimes of the lower extremities, (*paraplegia,*) more commonly of one side, (*hemiplegia.*) In the operation of narcotics, the state of coma is commonly preceded by symptoms of cerebral excitement, manifest in the usual signs of intoxication and delirium, which vary in the case of different poisons. For these particulars, I must refer to works on toxicology and materia medica.

In conjunction with these symptoms, referable to the sensorial and voluntary functions, there are often symptoms of various affections of the excitomotory system of the medulla; at first they are those of excitement, such as convulsion, vomiting, hiccup, contracted pupil, &c. (§ 152.) Thus, the coma of apoplexy, and sometimes the stupor of narcotism, are occasionally accompanied by convulsions, (§ 150,) general or local; and I have elsewhere (§ 153) endeavoured to explain how these opposite effects on different parts of the nervous centres may arise from the same cause. But in cases of more extreme coma, the excitomotory power of involuntary motions becomes impaired, the breathing is stertorous and imperfect, the actions of coughing and expectoration are not easily excited, deglutition becomes impossible, the pupils are dilated, emetics fail to excite vomiting, the sphincters are relaxed, and involuntary discharges of urine and fæces take place. This last group of symptoms was before noticed as the fatal part of coma and narcotism, (§ 154.)

It is a question whether the functions of the brain can be completely suspended for any length of time without those of the medulla suffering also. During sleep there is not complete insensibility or suspension of volition, for movements are then made in consequence of unpleasant sensations, yet without the sleep being broken. It is probable that in the trance of nervous subjects, of hysteric coma, (§ 141,) either sensation or volition is not entirely abolished; but it is difficult to ascertain the truth in these cases, for the patients often deceive themselves as well as others. But in the heavy sleep of intoxication, and in the stupor of coma, in which pinching scarcely excites any evidence of consciousness, the functions of the medulla seem to be also impaired, for the breathing is slow and stertorous, and irritations of the nose and eyes less readily than usual excite the motions of sneezing and winking. It is in proportion as these functions are impaired that coma becomes dangerous; and it is because they are not materially impaired in nervous or hysteric stupor, that this is unattended with danger. It appears probable, however, that coma, when complete, may cause death by the abolition of sensation only. Although the movements of breathing are ordinarily independent of the consciousness or will, yet such is not the case of the extraordinary movements which commonly take place in a deep breath or sighing, when the ordinary action is impeded by posture, fatigue, or any other cause. A sensation of want of breath is then felt, and an effort is made to relieve that sensation. But when sensibility and voluntary power are suspended, these supplementary efforts are not made; for want of them, the respiration may be insufficiently performed, and the lungs may become congested; this congestion further impairs the involuntary part of the process of respiration, and the symptoms and effects of apnœa are gradually induced. Under such circumstances, it is of great importance to place the patient in such postures or other circumstances, as shall most favour the movements of breathing, and to remove pulmonary congestion by the proper remedies, should it arise.

Snoring arises from a relaxed state of the soft palate, and is of little moment so long as the movements of breathing are sufficiently strong and frequent; but when the respiratory powers are impaired, stertor is not only a sign but a cause of obstruction to the passage of the air, and should be prevented as much as possible by changing the posture of the patient.

The most dangerous kind of coma, then, is that attended with symptoms of impaired excitomotory function, these symptoms being apparent especially in connection with respiration. In apoplexy, contraction of the pupil of one or both eyes is of very unfavourable import, because it indicates an excitement of the upper portion of the medulla, whilst the brain is oppressed; such a combination can only proceed from the partial operation of a clot in the substance of nervous centres, compressing one part and irritating another.

629. That death should ensue from *injured function of the medulla oblongata and spinalis* is quite intelligible, when it is considered that on this portion of the nervous system the ordinary act of breathing depends. This mode of death, like the last, is by apnœa; but the death, or failure of function, here begins with the nervous link of the chain of actions constituting the process of respiration, whereas, in simple apnœa, it commences with the mechanism of the breathing apparatus.

This death may be called death by *paralysis*, and as in other cases of paralysis of an excitomotory function, (§ 144,) it may be caused by suspended function, either of the nervous centre, (medulla oblongata,) or of the afferent nerves, (par vagum and sympathetic,) or of the efferent nerves, (phrenic, intercostals, and spinal accessory,) which complete the respiratory circle. Of influences which destroy the function of the medulla oblongata itself, may be mentioned, hæmorrhagic effusion into its substance or upon it, fractures of the base of the skull, and any very considerable pressure on the whole encephalon. Some poisons seem to affect the medulla more immediately than the brain. Thus, animals poisoned with woorara, essential oil of bitter almonds, conia, belladonna, and perhaps some other poisons, are affected with gaspings and other signs of impaired function of respiration before they lose consciousness; according to the experiments of Sir B. Brodie and others, they die simply from suspension of respiration, and if this process be artificially maintained for a time, the animals may sometimes recover from the effects of the poison. The same remark in some degree apples to opium and its active principle, but less distinctly, for these early induce coma, and often impair the action of the heart also. Experiments are wanting to establish the elementary operation of this and other poisons, as the functions are now viewed by physiologists. In some cases in which I have seen animals die from rapid hæmorrhage, the respiration has ceased for some seconds before the heart's action; and from the peculiarly laboured state of the breathing, and late retention of consciousness, I conclude, that death from hæmorrhage, in some instances at least, is due to suspension of the function of the medulla.

630. The division of the eighth nerves in the neck in animals illustrates one mode of inducing death by paralysis. These are the chief incident or afferent nerves from the lungs to the medulla, transmitting the impressions which excite the motory nerves of the muscles of respiration. When they are divided, the breathing is imperfectly performed, and expectoration and cough cannot take place; apnœa, therefore, gradually follows. Although we have not a result to the same amount exhibited in disease, yet we have an approach to it in the dyspnœa, sometimes constant, sometimes in paroxysms, caused by pressure of tumours on these nerves, or by malignant disease involving them.

631. The third mode in which the nervous link of respiration may be broken, injury to the excitomotory column of the spinal marrow or its branches, is exemplified in the case of breaking the neck, or dislocation of the upper cervical vertebræ. Pithing an animal effects the same thing. All parts supplied by nerves from below the injured portion of the medulla become paralyzed, and therefore their motions cease. Diseases in the vertebræ, in the spinal cord, or in its membranes, have been followed by similar results; and the functions of the several nerves of respiration are illustrated by these cases. I have known disease affecting the cord at the upper cervical vertebræ cause loss of motion in all parts below the neck except the diaphragm, which is supplied by the phrenic nerve, and through which for a while respiration was wholly carried on. The patient afterwards regained power in the spinal accessory nerve, by which he was enabled to elevate the upper part of the chest; and subsequently some power was for a time restored to the superior intercostal nerves and muscles.*

* Med. Chir. Trans., 1843.

In other cases, disease of the spinal cord creeps from below upwards, beginning with paralysis of the lower extremities and pelvis, then reaching the dorsal spine, palsying the intercostals, and at last reaching the neck. The advance or retrogression of all these symptoms are of great importance in the prognosis of such diseases.

632. Besides the respiratory function, the functions connected with excretion are dependent on the integrity of the spinal cord; they fail when it is seriously injured, and this failure may furnish symptoms of death beginning at the spinal cord. When the cord is injured only at a point, and remains healthy above and below it, the injury may merely intercept the transmission of sensation upwards, or of volition downwards, beyond the injured point. Hence, there may be loss of sensation, or of voluntary motion, or of both, in the lower portions of the body. If this reach the urinary apparatus, the power of spontaneously voiding urine is lost. But the reflex or independent excitomotory influence of the spinal cord remains; hence, the sphincters and the bladder retain their power, and when the catheter is introduced into the bladder, it contracts as usual, aided by the voluntary power remaining in the diaphragm and abdominal muscles. We have before noticed, (§ 149,) that under these circumstances the muscles of the lower extremities retain and accumulate their irritability, and although the will has no command over them, yet tickling, or even touching them, may excite them to contract. The exercise thus kept up seems to be sufficient to preserve their nutrition, for they do not waste away.

But it is quite different if the spinal cord be extensively injured, as by crushing, softening, or a considerable effusion of blood or pus into its sheath. Its function then ceases, not only as a communicator of sensation and voluntary power to the lower parts of the body, but also as a source of that involuntary excitomotory power by which the sphincters contract and the urinary bladder evacuates its contents. Hence, there is constant dribbling of urine, yet without the power completely to empty the bladder. The fæces are discharged unconsciously, and without the power of control. The limbs are not only insensible and powerless to the will, but their muscles can no longer be excited by tickling. they lose all motion, and the blood-vessels lose that influence which the nerves of all orders exercise upon them. It is not surprising, under such circumstances, that the death which has begun in the spinal cord should spread to the parts whose functions it can no longer maintain. The urine, imperfectly discharged, putrefies, and causes inflammation of the bladder, which may gradually extend to and stop the function of the kidneys. The intestines become distended and obstructed with gas and pent up fæces.

The limbs lose their proper circulation for want of motion and nervous influence on their muscles and vessels; their nutrition fails, they become œdematous, partially inflamed, livid, and run into gangrene; and all these changes are so many signs of the progress of death which has begun in the spinal cord.

From the remarkable effect of cold and some poisons on some of the lower animals, inducing paralysis of the hinder extremities, it is probable that these agents are capable of especially injuring the function of the spinal cord, beginning with the remote part. Has the gangrene of the lower extremities, sometimes induced by the use of ergotted corn, any connection with an injured function of the spinal cord?

Death of the medulla supervenes on that beginning with coma and asthenia in many cases; and as its involuntary excitomotory function is the guardian of many processes essential to life, the symptoms connected with it are of great importance in connection with prognosis.

633. *Necræmia*, or *death beginning with the blood*, are terms which I venture to give to those fatal cases in which the first and most remarkable change is exhibited by the blood. In typhoid fevers and others of the malignant or pestilential kind, none of the solids of the body constantly exhibit such an early change of function or of structure as would warrant us in tracing disease and death to them. It is true, that the functions of many solids are impaired—the muscular and nervous systems, secretion, digestion, assimilation, and nutrition, all suffer, but the very universality of the affection seems itself to point to some cause more general than can be found in any individual function; and such a cause may be found in the blood. The blood, at an early period of these diseases, when they occur in their worst form, exhibits changes which show that disorder begins with it, and this disorder may reach to a fatal degree. The appearance of petechiæ and vibices on the external surface, the occurrence of more extensive hæmorrhages in internal parts, the general fluidity of the blood, and frequently its unusually dark or otherwise altered aspect, its poisonous properties as exhibited in its deleterious operation on other animals, (§ 258,) and its proneness to pass into decomposition, point out the blood as the first seat of disorder, and by the failure of its natural properties and offices as the vivifier of all structure and function, (§ 180, 262,) it is plainly the medium by which death begins in the body. How far the change in the blood is in its structure (§ 189) and vital properties, (§ 201,) or in its chemical composition, (§ 182,) further research alone can determine; the vivifying function of the blood depends on all these combined, and it is this function which

obviously fails. Hence the complete adynamia, or general prostration of all living powers, which occurs where this cause of death is most powerful. The blood, the natural source of life to the whole body, is itself dead, and spreads death instead of life. Almost simultaneously, the heart loses its power, the pulse becoming very weak, frequent, and unsteady: the vessels lose their tone, especially the capillaries of the most vascular organs, and congestions occur to a great amount, (§ 290, 293,) the brain becomes inactive, and stupor ensues; the medulla is torpid, and the powers of respiration and excretion are imperfect; voluntary motion is almost suspended; secretions fail; molecular nutrition ceases; and at a rate much more early than in other modes of death, *molecular* death follows close on *somatic* death—that is, structures die and begin to run into decomposition as soon as the pulse and breath have ceased, nay, a partial change of this kind may even precede the death of the whole body, (somatic death—Dr. Prichard,*) and parts running into gangrene, as in the carbuncle of plague, the sphacelous throat of malignant scarlatina, and the sloughy sores of the worst forms of typhus, or the putrid odour exhaled even before death by the bodies of those who are the victims of similar pestilential diseases, are so many proofs of the early triumph of dead over vital chemistry.

634. We have hitherto represented an extreme case; but there are many lower degrees in which disease begins with the blood, and various disturbances and reactions result. The causes which appear thus primarily to affect the blood are especially endemic, epidemic, and infectious influences, called poisons, (§ 81, 88, 93,) certain animal and vegetable poisons, as that of the most venomous reptiles and fungi, and probably some mineral poisons, as sulphuretted hydrogen, selenium, and, in part of its operation, arsenic. The direct influence of all these agents is depressing, (§ 105,) and when they operate in large quantities, or in a concentrated form, the vital powers fall quickly into a state of adynamia or prostration, which soon ends in death, as we have already described it, the blood first and most constantly manifesting a change. But if the noxious influence is in smaller quantity, or more diluted, the vital powers react against it (16) in various ways, the object of which can often be plainly discerned to be its expulsion from the system. The shivering, hot stage, and sweating termination of paroxysms of intermittent fever; the similar but less marked series of febrile movements which occur in slight forms of remittent and continued fevers; the profuse and violent fluxes from the stomach and intestines in cholera, dysentery, and epidemic diarrhœa, and the similar discharges induced

* See Dr. Symond's interesting essay on "Death," in the Cyclopædia of Anatomy and Physiology.

by poisonous ingesta, are instances of the operation of vital re-action attempting the expulsion of the noxious matter and of that part of the animal fluids that had been corrupted by it. But these struggles in many instances constitute serious diseases, in which life may be compromised by the violence and exhausting effect of the reaction as much as by the prostrating influence of the cause of the disease; and in these more complex affections, individual organs may especially suffer in different cases, and the danger and the cause of death may be less in the changed condition of the blood than in the affections of particular organs, or the exhaustion consequent upon them, which destroy, not by necræmia, but by coma, asphyxia, or asthenia, modes of death already considered.

635. But the injurious effect of these poisons may be still more completely prevented when their quantity is small and the living powers are vigorous. A diarrhæa, a profuse sweat, or a free flow of urine, sometimes carries off the commencing disease. The intestines, the skin, and the kidneys, appear to be the proper emunctories through which morbid matter is expelled. The peculiar fœtor of the secretions from the bowels in typhoid fever, and the beneficial influence of moderate diarrhœa, which removes them in the early stage of fever, seem to be an example of the elimination of a morbific matter; and I have before suggested (§ 404, note,) that the follicular inflammation and ulceration of the intestines in fever may arise from the excessive irritation of the follicles in the exercise of this eliminating function. Again, with regard to the kidneys, it has been before mentioned, that granular degeneration, which impairs their function, renders the body peculiarly liable to contract epidemic and infectious diseases, and to succumb under them, (§ 260.)* This renders the prognosis unusually unfavourable in these cases. The same remark extends, and for the same reasons, to persons who have been habitually intemperate. On the other hand, those whose kidneys are naturally active more effectually resist disease, and more readily throw off its effects, (§ 448.) In like manner, it is well known that persons with a naturally dry skin do not so readily get rid of a fever as those in whom perspiration is readily excited.

636. Besides the extrinsic influences already mentioned, (§ 634,) as first attacking the blood, and in extreme cases injuring its composition, and causing its death, there are others originating in

* This has been exemplified in the case of an epidemic erysipelatous angina, which attacked several patients of the University College Hospital last spring, (1843.) Out of about a dozen cases in which persons affected with various diseases were attacked, three died from the erysipelas extending to the larynx, and in all these the kidneys were granular and the urine albuminous.

the body itself. Thus the processes of gangrene and suppuration sometimes infect the blood with a septic poison, (§ 470, 475,) and cause death in a manner and with symptoms like those of the poisons above noticed. The sudden suppression of the excretions of urine or bile, from disease, or under the influence of any severe shock, also seem in some cases to operate by injuring the properties of the blood; whilst in other instances it distinctly induces coma or asthenia. We have before adverted to retention of excrementitious matter as a cause of *cachæmia*, or depraved state of the blood, (§ 249, 564;) so we now find that, in an extreme degree, it may cause *necræmia*, or death of the blood.

637. The symptoms which should make us apprehend the approach of death by necræmia may be gathered from the preceding descriptions. Those symptoms generally called typhoid, putrid, or malignant, belong especially to this class of death. For example: a congested appearance of the whole surface, the colour being dusky or livid, and extending to the conjunctivæ, tongue, and fauces; various, slight, exanthematous, or papular patches on the skin, often with petechiæ; more extensive hæmorrhages in form of ecchymoses, or oozing of thin bloody fluid from the gums, nostrils, and sometimes from other passages; extreme prostration of strength, with an obtuse state of all the senses and mental faculties, sometimes combined with delirium and twitchings of the limbs; half-closed eyes and dilated pupils; a very frequent, weak, and soft pulse; frequent and unequal respiration; no appetite; intense thirst; a dry, brown tongue, with dark sordes on the lips and teeth; a progressive fall of temperature, which may have been elevated at first; often cold, clammy, and fœtid perspiration; hiccup; subsultus tendinum; scanty, offensive urine; involuntary discharges.

Some diseases of the same class are modified by peculiar effects. Thus in malignant cholera, excessive discharges of serum, by vomiting and by stool, reduce the blood to such a spissitude, that it will no longer circulate through the vessels; the pulse ceases, and the surface becomes blue and cold from the darkness and stagnation of the blood, and shrunk from the exhaustion of its fluids. In yellow fever, altered blood is ejected from the stomach in the form of what is called black vomit. But to pursue this subject into further details belongs rather to the department of special pathology.

638. It has been before mentioned, that the complete distinction of these different modes of death is almost exclusively confined to cases of speedy or sudden death. In the slower dissolution, by which diseases generally prove fatal, all functions and struc-

tures are more or less involved; and the life in all is dwindled down to so slight a thread, that when it breaks in one, others scarcely retain it long enough to enable us to say that death begins distinctly in any part.

CHAPTER VII.

PROPHYLAXIS AND HYGIENICS.

639. *Prophylaxis* is the guarding against a particular disease; and *hygienics* relate to the prevention of diseases in general, or the preservation of health. The former is appropriately connected with special pathology; and it should be founded on a due knowledge of the causes, nature, and tendencies of diseases, and of the various means in diet, regimen, residence, and medicine, which are capable of removing the causes of disease, or of preventing or counteracting their operation.

640. *Hygienics* consist in the knowledge and application of those means, by which the structures and functions of the body may be kept in that normal state which conduces to their continued welfare—that is, in *health*, (§ 6.) We have found, that both structures and functions have the elements of disease in themselves, when any thing disturbs their due proportion. We have noticed the circumstances which lead to such disturbance, both in connection with the causes of disease, (under the head *Etiology*,) and in connection with its intimate nature, (in the division *Pathology proper;*) and remarks on the means of preventing or counteracting those circumstances were introduced in the context to a sufficient extent to suggest the principles of hygienics. Want of time prevents me from introducing here, as I had intended to do,—1. A brief review of the chief causes of disease, for the sake of pointing out the means of preventing their occurrence, or resisting their operation; and, 2. A short account of those circumstances which most promote the healthy condition in the several functions and structures of the body.

[641. The object of hygiene is the preservation of health and the prevention of disease; and hygienics include every thing which tends to accomplish these ends. Although hygiene has been called the medicine of healthy individuals, it is still applicable and even indispensable to invalids, and is often of more service to them than medicine itself; for whilst the efficacy of many remedies may be doubtful, the propriety of hygienic measures is universally admitted. By their aid alone, without a resort to the materia medica, the majority of acute disorders will terminate favourably; without them our best directed efforts will often prove unavailing. We frequently see patients in bad hygienic conditions, perish in spite of able physicians, and an abundance of remedies, and the mildest diseases converted into mortal ones from similar reasons. The crowding of patients into narrow, ill-ventilated places, the contamination of the air, the absence of cleanliness, the want of suitable clothing, exposure to cold and wet, errors of diet, mental depression, fatigue, collectively, invariably, produce terrible effects; whilst in a large number of acute affections of the severest kind, recovery occurs without a resort to any active remedy, merely under general hygienic measures.

642. Wherever the conditions most favourable to the development and preservation of the health of the body, are most completely fulfilled, in the same proportion do we find least sickness and mortality. Millions annually perish from a neglect of the conditions which a Divine Wisdom has appointed as requisite for the protection of the body from disease; and millions more are in a state of perpetual suffering and pain from simple inattention to the common principles of hygiene. From the moment of birth the infant is almost entirely dependent upon the condition in which it is placed, for the future development of its frame. The due supply of warmth, food and air, are the principal points to be attended to in the care of infant life; and on every one of them the greatest errors of management prevail. Thousands of infants annually perish from exposure to cold in the first few days of infancy, and subsequently from inattention to simple physiological principles which should regulate the amount of their clothing in accordance with the condition of the medium by which they are surrounded. Another source of injury is the constant transgression of the rules of diet, both as to quantity and quality, and inattention to the maintenance of a due supply of fresh and wholesome air. It is impossible for human beings to grow up in a sound and healthy state of body and mind, in the midst of a close, ill-ventilated atmosphere. Those who are the least able to resist its influence, die in infancy and childhood; whilst those who possess naturally more vigour of constitution, become enfeebled, and have their life prematurely cut off by disease, or are deprived of the enjoyment and blessings of health, dependent on a sound constitution. (Carpenter's Animal Physiology, p. 3.)

643. The work-houses of London, about a century ago, presented the astounding result of 23 deaths in every 24 infants, under one year of age. When an improved system of management was adopted, the proportion of deaths was speedily reduced from 2600 to 450, in a year. Here was an annual loss of 2150 lives, chargeable to ignorance, indifference or cruelty. At the

present day, every tenth infant perishes within a month of its birth.*

644. In the island of St. Kilda, 8 out of every 10 children die between the eighth and twelfth day of their existence. This alarming mortality is due not to the operation of any noxious influence in the position or atmosphere of the island, but solely to the filth in which the inhabitants live, and the effluvia which pervade their houses. The clergyman, who lives in all other respects but in the condition of his house, as those around him, has reared a family of four healthy children. In a lying-in institution in Dublin, at the conclusion of 1782, out of 17,650 children born alive, 2944, or nearly every sixth child, died within a fortnight. By the employment of additional means of ventilation the mortality was speedily reduced to only 419 out of 8033, or 1 in 19½, instead of 1 in 6; and it has recently been still further diminished. The following statement of the comparative number of deaths of children under five years of age, in London, during successive periods of 20 years, is additional proof of the benefit derived from increased attention to hygienic measures. In the 20 years subsequently to 1730, out of every 100 children born, 74½, or nearly 3 out of 4, died before they were five years old. In the succeeding 20 years, the proportion of deaths was reduced to 63 in 100, or less than two-thirds. Between 1770 and 1790, it was only 51½ in 100, or little more than one-half. In the 20 years succeeding 1790, it was further reduced to 41½ in 100, or little more than two-fifths. And between 1810 and 1830 it was no more than 32 in 100, or less than one-third.†

645. The health of the adult suffers scarcely less from excesses in mental or bodily labour, sensual indulgence, or from privation of the conditions essential to life—warmth, food, and air. A great improvement has taken place in the duration of human adult life from increased attention to hygienics. The average duration of life among the ancient Romans, when compared with that of the English of the present day, was as two to three. Within the last hundred years the term of human life has undergone a considerable increase. But much yet remains to be done by which further improvement may result. The mortality in France, and probably in the whole civilized world, is more than twice as great among the poor in numerical proportion, than amongst the classes in easy circumstances.

646. By a reference to the chief causes of disease, (chap. 1, sect. II,) we shall ascertain the requisite conditions necessary to the preservation of health; any departure from them is almost certain to entail serious consequences.

* Dr. A. Combe on the Physiological and Moral Management of Infancy.

† Carpenter, loc. cit.

647. The annual slaughter in England and Wales from preventible causes of typhus which attacks persons in the vigour of life, appears to be double in amount to what was suffered by the allied armies in the battle of Waterloo. The higher mortality of English women by consumption may be ascribed partly to the in-door lives they lead, and partly to the compression preventing the expansion of the air by costume. 31,090 English women die in one year of this incurable malady, (Letter to the Registrar General, p. 73, 1841.) The daughters of the poorer classes are deprived of that vital air, and free exercise, without which the circulation becomes languid and the blood vitiated, when as dress-makers they are confined all day and a portion of the night in crowded, ill-ventilated apartments. "It is not doubted," says Mr. Chadwick, "by medical witnesses that one-third at least of the healthful duration of adult life amongst milliners, dress-makers, and tailors, will be found to be destroyed by ignorance of the want of ventilation." The health of girls in the higher classes is sacrificed "to those eternal *accomplishments*, which, with small benefit to the intellect and none to the feelings, inevitably dwarf and dwindle the body, and too often lay the beauteous fabric in the dust. Many hours to music, many to drawing, many to fancy-work, ome to languages, and few—but very few—to exercise in the open air 'wear through the longest day.' When exercise is taken it is ofien in some public walk, under the superintendance of some silly and ignorant governess, by whom every ebullition natural and healthful to youth—the jocund laugh, the run and the leap—are repressed as ungenteel—that stupid and vulgar word to which so much of the health and happiness of youth is sacrificed. In an education calculated to draw forth the powers of the mind and body all should be vigorously done. But this is overlooked in female education. During the long hours of lessons in drawing, music, &c., the attention becomes languid, the mind weary, objects impress it feebly, and much of the time that is thus literally wasted would be infinitely much more usefully spent in play. A shorter period of vigorous study and a longer one of bodily exertion of a different kind from what we have witnessed and endeavoured to describe, would send young ladies forth to the world from their homes or seminaries of education at once better instructed and more healthful than we now see them."

648. The pernicious influence of a dense population on the diseases of the respiratory apparatus is unequivocally proved. The close and foul air of the cotton mills and other manufactories is a powerful cause of consumption, the respiration of a deteriorated atmosphere rapidly inducing the tuberculous cachexia, as Sir James Clarke tells us.

649. Insufficient and ill-proportioned diet is another constant cause of disease. Observation and experiment have fully proved the absolute necessity of considerable variety of food for the preservation of health and life, (§ 58.) Experience demonstrates that the aliment of man must be presented to him in a variety of forms, and must not be restricted to the vegetable kingdom alone. It was formerly supposed that scurvy, a disease of nutrition, was only produced by the use of salt provisions, but it is now found to be engendered by restriction to any one kind of diet. Scurvy frequently attacks the Indian of South America, who lives almost on rice alone. It has reigned epidemically in the rice grounds of Lombardy and Piedmont. The same disease prevailed in an epidemic form in Germany in 1771 and 1772, years of scarcity, when many of the inhabitants were obliged to live on legumes, roots, and even the bark of trees. Scurvy affected numbers of the poor people in France in 1812, 1816, 1817, when even wild plants were employed as food in consequence of scarcity. How far typhus, scarlet fever, and other epidemics of large towns, are affected by an imperfect nutriment is an interesting subject for inquiry.

650. Exercise is another hygienic measure of the first importance. Walking, progressively increasing the amount, is an excellent restorative. Horseback exercise has been much and justly lauded by Sydenham. A cheerful companion is indispensable in walking. "Languor will at first ensue, but, as this goes off, an exhilarating glow pervades the frame, ending in cheerfulness, craving appetite, and if properly persevered in, complete restoration of all the excretions." (McCormac.) A patient may ride one day, and walk the next; it is often useful to alternate active with passive exercise.

651. Attention to the moral condition of the patient should not be overlooked. Entire change of scene and occupation is often alone sufficient to renovate health, and effect an entire recovery. With students the mental must not be cultivated to the prejudice of the corporeal powers. The morning is a better time than night for study; and if intense, it should be followed by exercise in the open air.

652. A few general rules on the hygienics of sick persons will not inappropriately close this chapter.

Patients labouring under acute disorders should be placed in large, dry and well ventilated apartments. The temperature of the room should be equable and moderate; the amount of light must be regulated by the character of the disease. When the air is contaminated by noisome exhalations, fumigations may sometimes be advantageously resorted to. If the room in which the patient is taken ill be small, badly ventilated or damp, he should be removed, if possible, into a larger one, free from these inconveniences, as the risks of moving, even in severe febrile affections, are less than is usually imagined. (Chomel.)

653. Great cleanliness should be strictly maintained, and for this purpose the linen should be frequently changed; but not so as to fatigue the patient. It may be done even whilst the patient is sweating copiously, and great comfort will result. To effect this, warm cloths, passed underneath the shirt, should envelop successively the legs, thighs, abdomen, chest, and even the neck, so that the arms alone will be momentarily exposed to the air. Patients should never be permitted to sleep on feather beds, without an intervening mattrass. It is often necessary to employ auxiliary means to receive the excretions, impermeable cloths to protect the bed linen, and cushions to obviate pressure on certain parts of the body. The position of the bed should vary according to the nature of the disease.

654. The employment of suitable aliments and drinks in acute affections is of great importance, and adds materially to the comfort of the patient. There are two extremes to be equally avoided; nourishing patients too much, and not nourishing them enough. Hippocrates thought it safer to err on the side of excess, than for patients to observe total abstinence. In acute febrile affections, you should observe a just medium. Proscribe all kinds of solid aliment, but permit the use of fluids slightly nutritious, such as the farinaceous articles, light broths of veal and chicken, the juicy fruits, etc., when the febrile movement is not too high. In the low forms of fever, when the strength has to be supported, it is indispensable to nourish the patient, and severe adynamic symptoms may often be prevented by timely nourishment. The injudicious use of food has the power, it has been remarked by a celebrated authority, of nourishing the disease, and not the patient.

655. It is of immense importance in all acute disorders that the excretions of the patient should be immediately removed. Perspiration chills the body; the urine and fecal matter, already compromised, are disposed to speedy decomposition, and impart noxious qualities to the air. When involuntarily excreted their contact with the body is positively injurious, by provoking eruptions, excretions, and even sloughing.

656. In acute diseases, repose and quiet are indispensable. Sydenham thought that fever patients should be made to rise every day, and that doing so obviated the tendency to delirium. There is no doubt but that patients should be daily placed in an arm chair, or on a bed, according to their strength, in order to allow their own bed to be made; if this cannot be done they can be removed to another portion of their bed, whilst the necessary

change is made. When a patient is too feeble to change his position in bed, it should be done for him frequently; it adds materially to his comfort, prevents the formation of sloughs, and obviates the tendency to pulmonary congestion, so frequent in protracted fevers.

657. Sleep is generally a favourable symptom in acute diseases. Every thing which by acting on the senses, or the *moral* of the patient will prevent it, should be obviated. From the same motives sleep should not be broken to administer medicines, without the necessity is urgent. Sleep may sometimes be induced in convalescence, by causing the patient to rise, and readjusting his bed. Gentle friction with the fingers on some part of the body disposes to somnolency.

658. The sensations, the emotions and intellectual faculties all demand, in a special manner, the attention of the physician. The removal of all moral or mental circumstances, which either have produced or keep up the morbid condition, is important. Conversation should be banished from the sick chamber; when low it is annoying; when loud, fatiguing and exciting. The influence of the passions of the mind are so great that nothing should be neglected to give them a favourable turn. To this end the physician should obtain and deserve the confidence of the patient, (careful attention and great interest will frequently accomplish this,) and he should be careful that nothing in his manner or speech should betray anxiety or uneasiness. Patients generally receive with satisfaction assurances of the successful termination of their complaint from their physician. The fear of death adds materially to the danger, in a majority of instances, and "the physician," says Chomel, "who allows his patient to suspect the danger of his position diminishes his prospects of recovery." Sir H. Halford, in some judicious remarks on the duty of a physician, in withholding from, or communicating to, a patient the probable issue of a disease displaying mortal symptoms, says, "that the first duty of a physician is, to protract the life of a patient by all practical means."* The probability of a fatal issue should, therefore, be communicated to the friends, and, except under very peculiar circumstances, never to the patient.

659. In chronic diseases, hygienics are of immense utility. Change of habitation and climate, voyages by land and sea, a sojourn at some fashionable watering place, &c., often succeed in restoring health when all other remedial measures have failed.

* Lond. Med. Gaz., vol. vii., p. 602. C.]

THE END.

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