Lectures on the urine, and on the pathology, diagnosis and treatment of urinary diseases / by John Aldridge.

LECTURES ON THE URINE,

AND ON THE

PATHOLOGY, DIAGNOSIS, AND TREATMENT

OF

URINARY DISEASES.

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TO

THE MEMBERS

OF THE

PATHOLOGICAL SOCIETY OF DUBLIN,

This Little Work

IS

RESPECTFULLY DEDICATED.

LECTURES ON THE URINE,

&c. &c.

INTRODUCTORY REMARKS.

By the advice of friends, on whose opinions I place reliance, I am induced to present these lectures to the profession in a collected form. They originally appeared in a periodical publication,* but under such circumstances, the reader could with difficulty follow the connection of the several parts, which necessarily were published at distinct and remote intervals. In their present form, I believe they will be found useful to practitioners, as supplying a want which is generally experienced.

It has not been my object, in the following pages, to inform the chemist, or to argue peculiar doctrines. For the more abstract and scientific knowledge of urinary analysis, I willingly refer to the works of Bird, Rees, and Simon. And, if the reader meet with, in these lectures, unusual views in pathology or diagnosis, he will find them fully discussed in my "Notes on Urinary Diseases," inserted at various times in the Dublin Medical Journal. These views have been fully sanctioned by many of the most eminent physicians and surgeons of the day. If, in these lectures, I introduce chemical details, they are confined to those which are necessary for explaining certain processes of morbid changes; or, for describing such methods of analysis as are best cal-

* Dublin Hospital Gazette.

culated for diagnosis; in either case, being equally indispensable to enlightened practice. And, if in the enunciation of opinions on points of pathology, diagnosis, or treatment, I may seem to speak dogmatically, it is because I believe them to be true, and to have been elsewhere argued successfully, and that I have been most anxious to avoid any unnecessary book-making.

It remains to point out in what manner the reader may render this little work most useful to himself. The principles which I wish to inculcate can be alone understood by studying the following lectures, continuously, throughout; but, for the purposes of reference, in aid of those who may wish to examine the diagnosis, pathology, or treatment of any particular disease, there is an index added, sufficiently copious and intelligible, it is hoped, for every useful object.

LECTURE I.

COMPOSITION OF THE URINE, PHYSICAL PROPERTIES.

HEALTHY urine is, when freshly passed, a clear liquid of an amber yellow colour; it possesses a peculiar aromatic odour, which nearly disappears by cooling, but again becomes sensible when we re-heat it. Its taste is disagreeable, saline, and bitter. On cooling it becomes slightly turbid, and deposits a light cloud, which has generally been called mucus. Its specific gravity varies by a great many circumstances, and cannot be considered abnormal between the limits 1.012, and 1.026. Its temperature varies, when passed, from 96° to 98° Fahrenheit. The quantity secreted by an adult during the day is usually between a pint and a half and three pints.

The physical characters of healthy urine are found to differ slightly in different individuals, and at different times in the same individual. It results from the observations of M. M. Rayer and Guibourt that the urine of infants is transparent and nearly colourless; inodorous, nearly neutral in its reaction, giving off, during evaporation, a smell similar to veal broth, of a low specific gravity. The same observers have found but little difference between the urine of the aged and adult. The quantity of drink, the amount of perspiration, &c., have the greatest influence on the physical characters of the urine; thus the *urina potus* is more abundant than the *urina cibi*; the former being that which is secreted after the taking of light vegetable food and emollient drinks; the latter, after the process of digestion has been concluded. In a similar manner, the use of the bath has been found to increase the quantity and diminish the specific gravity of the urine; this liquid is found to be more abundant and watery in winter than in summer: and the warmth of bed diminishes the necessity for passing water, by encouraging perspiration. Fear, terror, and other passions of the mind, are observed to possess an influence in modifying the quantity of urine, sometimes causing its suppression, but more frequently rendering it extremely copious. Moreover, M. Le Canu has ascertained that the solid and essential constituents of the urine are secreted in equal quantities, in equal times, by the same individual: but in unequal quantities, in equal times, by different individuals: so that the quantity and specific weight of urine which would be natural in one person, may be an evidence of disease in another; and we cannot be justified in regarding as morbid, varieties in the amount of this secretion, in different individuals, unless they are extreme.

CHEMICAL COMPOSITION.

The following is the analysis of the urine, made by Berzelius in 1809, which I select, partly on account of the high character of this chemist for extreme accuracy, and partly because it will enable me to point out the changes of opinion which have since taken place.

Water, - - -	933,00
Urea, - - -	30,10
Free lactic acid, Lactate of ammonia, Extractive matters, -	17,14
Uric acid, - - -	1,00
Mucous of the bladder, -	0,32
Sulphate of potash, - -	3,71
Sulphate of soda, - -	3,16
Phosphate of soda, - -	2,94
Biphosphate of ammonia, -	1,65
Chloride of sodium, - -	4,45
Chloride of ammonium, -	1,50
Phosphate of lime, and Phosphate of magnesia,	1,00
Silica, - - -	0,03
	1000,00

According to this analysis, the specimen of urine examined by Berzelius contained 67 grains of solid matter, dissolved in 933 grains of water. Now, this is the quantity of solid matter contained in urine of the specific gravity of 1,029, a density beyond the limits of health, so that in urine of the specific gravity of 1,015, (which is about the average) there would be contained little more than one-half the quantity of the different constituents which you see mentioned above. The 67 grains of extract contained in this urine of sp. gr. 1,029, may be perceived to consist of 30,10 of urea, 17,14 of lactic acid and extractive matters, and 19,76 of uric acid and inorganic salts : but it is not to be supposed that the entire quantity of salts in

proportion to the animal matters, (19,76 : 47,24) or even the mutual proportion of the salts to each other, is constantly the same as what is stated above: for the inorganic salts are exceedingly liable to vary in their nature and quantities: for example, the entire quantity of salts in this urine might have happened to be 15 grains, instead of $19\frac{3}{4}$, and then the density of the urine would be 1,027; and thus in one specimen, with a density of 1,029, the amount of urea would be equal to 30 grains, and another specimen of 1,027, would contain precisely the same quantity of this organic substance. You may deduce from this example, that neither the specific gravity of the urine, nor the quantity of extract yielded by evaporation, even in connection with an analysis such as the above, will be sufficient to enable you to learn by calculation with any approach to accuracy, the particular proportions of the several constituents of this secretion.

With respect to the individual elements of the urinary secretion, as noted by Berzelius, you perceive lactic acid, and lactate of ammonia, among the number. Now, Liebig has lately shown that perfectly fresh urine does not contain any free acid, nor does it even contain lactic acid at all. What led Berzelius into the error of supposing that it contained lactic acid, was the necessity for employing a very large quantity of this secretion, which consequently required a long time for its evaporation, during which spontaneous changes in composition took place, and certain acids became generated. You are then to recollect that perfectly normal urine contains no free acid; but it is not the less true, that it always has an acid reaction with blue litmus paper; this acid reaction is due, however, to the presence of acid salts, and not to free acid.

Now, having shewn you that healthy urine does not

contain lactic acid or lactate of ammonia, you will at once see that the enormous proportion of 17,14 out of 67, or upwards of one fourth of the solid constituents of this important secretion, becomes classed, in the above analysis, under the title of extractive matters, or, in other words, substances whose properties are unknown. This plain and intelligible fact will at once demonstrate to you that, notwithstanding all that has been written, and the very valuable observations that have been made of late years upon this secretion, much remains to be investigated.

It is not to be supposed, however, that chemists have not endeavoured to penetrate this *terra incognita;* many attempts have been made, and some things have been discovered, isolated, and examined out of these 17,14 grains of extractive residue. Berzelius extracted from it a small quantity of saponaceous fat; and Liebig has separated a little hippuric acid; it is known to contain the peculiar colouring matters of the urine; but it is not the less true that our knowledge with respect to it is still exceedingly imperfect, and that it constitutes the field, in urinary physiology, into which all well directed scientific incursions must in future be made.

The following are the properties of this extractive matter separated as completely as possible from the defined constituents of the urine. It is soluble to a certain extent in absolute alcohol; more soluble in rectified spirits; (sp. gr. 0,840) and entirely soluble in water: ether has no action on it. Its solution in water putrefies very rapidly, generating a considerable quantity of acetic acid, and during its putrefaction it gives off a peculiarly disgusting odour; not identical, however, with that of putrid urine: if the putrefaction is permitted to take place in a colourless glass phial, the latter will become blackened. A little of the dry extract

folded in silver foil, and heated in the flame of a spirit lamp for a few seconds, then unfolded, and moistened with a little water, stains the surface of the silver a dark brown. Some of the extract being heated in a glass tube, open at one extremity, and over this open end of the tube a rod moistened with strong muriatic acid being held, white fumes are produced, and a light charcoal remains. The watery solution produces precipitates with acetate of lead, sub-acetate of lead, proto-chloride of tin, and nitrate of silver; it is slightly troubled by corrosive sublimate and tincture of galls.

These properties point out that this substance contains oxygen, hydrogen, nitrogen, carbon, and sulphur. It is, moreover, evidently a mixture of very different compounds.

The portion soluble in alcohol is capable of being completely decolorised by digestion with animal charcoal. When obtained in the most concentrated form it is capable of without becoming charred, it is still viscid and tenacious. When heated in a tube it gives off a pyrogynous oil, water, carbonate of ammonia, and leaves a porous charcoal. It is probably a mixture of different compounds, but the attempts to separate them have not as yet been successful. Its most remarkable property is that by the putrefaction of its watery solution *much acetic acid becomes generated.*

The portion insoluble in alcohol is precipitable in white flocks from a concentrated watery solution by the addition of anhydrous alcohol. In this respect it resembles vegetable mucilage and pepsine, and, like the latter, it gives off ammonia when heated. The circumstance which principally struck me in its examination is, that *it has not any tendency to form acetic acid by putrefaction.*

Now, although the foregoing researches are exceedingly imperfect, they at least tell us that the urine contains con-

siderable quantities of organic compounds, nothing identical with which are found elsewhere. The generation of acetic acid has always hitherto been ascribed to the decomposition of vegetable substances. By destructive distillation this acid has been obtained from lignin, resin, and other organic compounds; but we have not hitherto recognised that it can be formed by fermentation, except out of alcohol, or something from which alcohol may be produced. It would appear that the acetic acid formed during the putrefaction of urine is compounded out of that portion of the extractive that is soluble in alcohol. This part of the urinous extractive most resembles amongst animal matters "the extractive matter of the blood soluble in water and alcohol," described by M. Le Canu: but the latter will not yield acetic acid by its putrefaction. In this latter respect this urinous extractive most resembles sugar amongst solid organic substances, but sugar does not contain nitrogen. It is possible, however, that this peculiar extractive may be a combination of some nitrogenous substance with sugar or dextrine, in which the peculiar chemical properties of each of the elements, (as, for example, the effect on polarized light,) may be rendered latent by the act of neutralization.

From the foregoing observations, you may perceive that, at the present day, we must make certain alterations in the analysis of the urine, as afforded to us by Berzelius. This I shall attempt in the following table, assuming that the specific gravity of the specimen is 1,029, and the amount of inorganic materials are the same as in his statement. It is to be observed that the principle called mucus by Berzelius, is now known to be the debris of the cuticular lining of the urinary passages, and named "epithelium."

Water, - - -		933,00
Urea, - - -		30,10
Uric acid, - - -		1,00
Epithelium, - - -		0,32
Extractive matter producing acetic acid by its fermentation. Extractive matter insoluble in alcohol. A little hippuric acid, and fixed oil, colouring matters, &c.		17,14
Sulphuric, phosphoric, and hydrochloric acids, potash, soda, lime, and magnesia,		18,44
		1000,00

COMPOSITION OF THE URINE IN THE INFERIOR ANIMALS.

Our notions with respect to the physiology of the urine will be very limited, if we confine our observations to the composition of this secretion in the human race. It is of the utmost importance to extend our researches to the nature of this secretion in other classes of animals: it is by this means we can alone hope to arrive at the essential purposes of this excrement, to discover the actual sources of its different ingredients in the living organism, and to ascertain the causes of its varieties.

The composition of the urine in the carnivorous mammalia is nearly the same as in man. The renal secretion of the lion, the tiger, the leopard, the hyena, and the panther, have been examined by Hieronymi. He has found the specific gravity of the urine of these animals to be high; varying from 1,045, to 1,076. The large quantity of urea and extractive matters is the cause of this high density, the uric acid very small in amount, and the inorganic salts being about the same as in man. The salts present in greatest quantity are the phosphates. The following is the composition of the urine of the lion, which may be taken as the type of all.

Urea and extractives - -	132,20
Uric acid, - - -	0,22
Epithelium, - - -	5,10
Sulphate of potash, - -	1,22
Chloride of ammonium, -	1,16
Earthy phosphates, -	1,76
Alcaline phosphates, - -	9,04
Acetate of potash, - -	3,30
Water, - - -	846,00
	1000,00

We here see that the entire amount of inorganic salts in the thousand parts is 16,48, while in a specimen of human urine considerably above the average, it was little more than 18. But, in man, we found the sulphates to be 6,87: the chlorides 5,95: and the phosphates only 5,59. On the contrary, in the lion the sulphates are only 1,22: the chlorides 1,16: while the phosphates are 10,80. The great deficiency of uric acid is also worthy of consideration.

The urine of herbivorous mammalia has also been examined; that of the horse by Fourcroy and Vanquelin; of the camel by Chevreul; of the rhinoceros and elephant, by Vogel; and of the cow, by Rouelle. In all these instances the quantity of urea has been very small, there was no uric acid, nor any alcaline or earthy phosphates; but, in place of these, a large quantity of carbonates, which are not found in the urine of carnivorous mammalia, and a considerable portion of hippuric acid. The following analysis of the urine of the horse will serve as a type.

Urea, - - - - -	7.0
Hippurate of Soda, - - -	24.0
Carbonate of Soda, - - -	9.0
Chloride of Potassium, - -	9.0
Carbonate of Lime, - - -	11.0
Water, an acrid oil, and epithelium,	940.0
	1000.0

It is to be remarked, however, that Chevreul found in the recent urine of the camel, and Rouelle of the cow, an abundance of urea ; so that its scantiness in other analyses was probably due to the rapidity of its decomposition. Vogel and Chevreul, moreover, state that they have detected traces of oxide of iron in the urinary secretions of the rhinoceros and the camel. According to Liebig, the urine of the horse, when taking much exercise, contains benzoic in place of hippuric acid. The urine of birds, reptiles, and fishes, is remarkable for consisting in great part of uric acid. This exists under the form of superurate of ammonia; and in the renal secretion of the ostrich, according to Fourcroy and Vanquelin, constitutes $\frac{1}{10}$th of its weight. Besides this, it contains sulphuric hydrochloric phosphoric, and, there is reason to believe, hippuric acids ; as well as potash, soda, and lime. According to Coindet, the urine of herbivorous birds contains urea, but he was unable to find this substance in the secretion of carnivorous birds.

You perceive, that the comparative examination of the urine affords materials for most interesting inquiry. Why should the urine of carnivorous mammalia abound in urea ; that of herbivorous mammalia in hippuric acid ; and that of the oviparæ in uric acid ? Why should the phosphates abound in the first ; be absent in the second ; and scanty in the third ?

The secretion of urine is not confined to the vertebrata. Jacobson and Treviranus have found uric acid, in a remarkable gland, usually filled with earthy matter in the mollusca, and which has been called the saccus calcareus. Treviranus has found the elements of the urinary secretion especially in snails and muscles. Blainville thinks it very likely that the purple and black secretions of many of the Cephalopoda, and Gasteropoda, are analogous to urine ;

such is *Indian ink*, the inspissated secretion of the Sepia officinalis.

Among insects also, traces of an urinary secretion have been observed. Brugnatelli found in the excrements of the silk worm urate of ammonia, carbonate and phosphate of lime, and phosphate of magnesia. Herold and Rengger consider the tubuli that terminate in the intestinal canal, usually designated "hepatic vessels," as being the sources of this liquid; and, in fact, Wurzer has detected urate of ammonia in the liquid contained in these vessels. Meckel accordingly looks on them as organs destined for secreting both bile and urine. I have myself been enabled to extract beautiful microscopic crystals of uric acid, by dissolving the excrement of the common house fly, and adding hydrochloric acid to the solution.

Non-essential Elements of the Urine.—It would be improper to assert that any particular element is essential to the composition of the urine; thus we have seen that this secretion in carnivorous birds does not contain any urea, and no uric acid can be found in the urine of the horse. Notwithstanding, we have also seen that certain principles are constant in the renal secretion of particular classes, and these we may consider essential in the variety of urine which they yield.

But, besides these constant constituents of each variety of urine, there are other substances commonly met with in this secretion, which cannot be considered as the result of the proper act of secretion, but mere exudations from the blood, into which they have been by chance introduced.

Many of these may be easily recognized by their physical or chemical properties; thus, the colouring matter of black cherries, mulberries, and some other fruits; of logwood, rhubarb, beet, and many roots, stems, &c., may be recog-

ized in the urine after the ingestion of the substances which contain them. Many of the essential oils can be detected by the odour that they give the urine ; the intoxicating principle of the amanita muscaria finds its way into this secretion, and endows it with its peculiar inebriating property : tannic acid may frequently be discovered in it after the use of astringents, by the addition of a persalt of iron, and Vanquelin discovered in the urine of the beaver the dye-stuff of the willow upon which it was accustomed to feed.

Many mineral substances likewise escape in this secretion, thus, nitrate of potash, yellow prussiate of potash, iodide of potassium, &c., may be detected in the urine soon after being taken into the stomach. It is most probable that the sulphates and chlorides of the urine proceed in a similar manner, from their being accidentally contained in the food or drink.

When oxalic acid is swallowed, either by itself or in some aliment, oxalate of lime subsides from the urine ; when benzoic acid is exhibited to man, it passes off from the kidneys in the form of hippuric acid.

Now, these are facts of great importance ; we find the composition of the urine is capable of being considerably modified by the nature of our aliments ; that different substances from without are enabled to pass into this secretion unchanged. This ought to make us pause in attaching too great an importance to slight modifications of this liquid, and hesitate in at all relying on its indications, except when corroborated by phenomena derived from other sources.

Many organic and inorganic substances, commonly employed as aliment or medicine, do not escape with the urine : such are the uncombined mineral acids, the oxides of iron and their salts, the preparations of lead and of bismuth, alcohol, ether, camphor, the colouring matter of cochineal,

&c. The alcaline salts of tartaric, citric, and acetic acid pass with the urine in the form of carbonates, these vegetable acids being decomposed in the torrent of the circulation.

Sources of the Urine.—We have seen that some of the elements of the urine consist of organic and inorganic matters that have been taken into the stomach, absorbed, escaped change in their passage through the blood, and finally, have been exuded from the kidneys. In this respect the kidneys resemble the leaves of plants, which, when unnecessary or noxious salts are absorbed by the roots, exude them from their surfaces ; this is probably the source of some of the sulphates and chlorides, as well as a portion of the anomalous extractive matters of the urinary secretion ; but there is, at the same time, little doubt but that a certain proportion of the sulphuric acid contained in the urine is formed by the oxidation of the sulphur, naturally contained in many of the tissues.

The more essential elements of the urine, however, cannot be regarded as unaltered constituents of food ; urea, uric acid, hippuric acid, &c., do not enter into the composition of our aliments ; we must look, therefore, for some other source for their production.

It has been supposed by some that urea and uric acid are formed out of the surplus materials of aliment after the abstraction of the materials necessary for growth ; this doctrine, however, is disproved by the fact that there will be no sensible diminution in the daily discharge of urea and uric acid subsequently to several days' abstinence from food. All the late important discoveries with respect to the chemistry of nutrition, likewise are opposed to this hypothesis : yet it still continues to influence medical practice, and we still continue to see physicians regulating the diet of their patients according to its principles.

Another hypothesis supposes all secretions to be formed within the circulation by the decomposition of the blood, or else separated in the glands, equally, by the decomposition of this liquid. Now, we certainly are destitute of any proof that this is not the case, but it has been considered unreasonable to think that the blood should be liable to decomposition, previous to the performance of its chief function—that of nourishing the tissues. This argument is manifestly a weak one.

The last theory which I shall allude to, is that which is at present generally most prevalent. I shall give it in the words of Tiedemann. "The physiologists of the modern iatro-chemical school say that there happens in the living organs a kind of acidification or combustion, in which the supporter of combustion is oxygen, that, quitting the arterial blood, unites itself with the organic combinations of the parts, and excites in them a species of burning. The nature of the excrementitious matters seems to announce that there is executed in the organs an operation in virtue of which the superior, or most complicated organic combinations, are converted into inferior, more simple compounds, or even into inorganic substances. The liquid excretion which escapes from the skin of certain mammiferæ, or the sweat, contains free acetic acid, chloride of sodium, phosphate of lime, and an animal matter. The ternary combinations which properly belong to the bile, the biliary resin and cholesterine, are as matters excremential of the blood expelled by the intestinal canal, at the same time as many different salts, with the undigested residue of the aliments. The most compound excremental liquid is the urine, in which, independently of two particular matters very rich in azote, urea, and uric acid, we find a great number of different salts. It appears, then,

that the complex animal combinations which the labour o assimilation prepared with matters received from without and that the act of nutrition carried into the organic tissues are decomposed by the vital manifestations of the organs and thus converted into organic combinations of the latter class, or even into inorganic combinations. This operation seems to consist in a special act, analogous to combustion moreover, they consider as a result the production o animal heat, which, in animals, is exactly proportionate to the rapidity of the renewal of the materials of the organism.' *Traité Complet de Physiologie*, p. 404.

I have preferred quoting the above account of this theory ; although it is obscure in many respects, because it is afforded by an enthusiastic vitalist, and one conscientiously opposed to chemical explanations of the phenomena of living beings. You will perceive, however, that the theory thus described is superior to either of the former because it proceeds from a *vera causa* ; we have no proof that the food becomes decomposed in building up the tissues ; nor that the blood becomes decomposed to form the secretions ; but we do know that the tissues decompose, because although constantly getting new additions, they never surpass the adult size; and we know, moreover, that the products of their decomposition must escape from the body.

But although this last theory best accords with facts, I do not think we are justified in assuming that the blood never becomes directly decomposed for the production of secretions, and we are to recollect that plants secrete, although their tissues, once formed, continue permanent.

Again, it is not probable that the elements of the urine are immediately produced by the combustion of the tissues ; some of the secretions are destined to be retained for subsequent uses in the economy ; such are bile, fat, saliva, pan-

creatic fluid, &c. ; and inasmuch as the excrements thrown out with the breath, urine, perspiration, fœces, &c., are exactly equal to the aliment, it appears to me evident, that the urea, carbonic acid, &c., must proceed from the combustion of the former class of secretions, and not directly from the decomposition of the tissues.

From the foregoing observations we may conclude, that the more essential elements of the urinary secretion are derived from the combustion of the non-eliminated secretions : that certain accidental materials present in this liquid, are unaltered elements of the food, merely exuded from the blood ; and that it is possible that some of the elements of the urine may be derived from the actual decomposition of the blood itself.

LECTURE II.

PUTREFACTIVE FERMENTATION OF THE URINE.

The urine, like other organic fluids, is liable to ferment ; the conditions that promote its fermentation are, as in other instances of the same process, the presence of a moderately warm temperature, the contact of atmospheric air, and the co-existence in the fluid of some substance which, itself liable to spontaneous decomposition, is fitted to act as a ferment—that is, to communicate the molecular motions of chemical change to bodies that otherwise would remain permanent. Thus, a solution of pure sugar might remain for an indefinite period unaltered ; but upon the addition of a small quantity of yeast, fermentation rapidly supervenes ; and this yeast itself is an albuminous principle, whose elements are so loosely held together, as to have a

tendency spontaneously to decompose into more permanent compounds, whose affinities are stronger, or in other words, to ferment; and it is the motion of molecular change which thus spontaneously occurs in the yeast, which, communicating itself to the particles of sugar mixed with it, that causes the latter to resolve themselves into carbonic acid and alcohol.

It is also to be remarked that the contact of atmospheric air is not always indispensable to fermentation, although in every instance it more or less promotes it; but it can take place without air, provided no element of the latter is requisite for the formation of the products. Thus, sugar may decompose into carbonic acid and alcohol without the contact of air, because all the constituents of these substances are already contained in the sugar; but, in the fermentation of alcohol, and the production of acetic acid, the presence of air is indispensable, for in that case a certain additional quantity of oxygen is requisite, both for the removal of hydrogen, and for the formation of the new compound.

Like sugar, urine can ferment without the presence of atmospheric air; the contact of this gas promotes the process, and the liquid will ferment more rapidly, at blood heat, in an open, than in a well stopped phial; but it is capable of putrefying in the latter, and it is well ascertained that this change is capable of taking place in the bladder, a viscus which, except under extraordinary circumstances, does not contain air.

The substance which usually acts in the capacity of a ferment in the urine is the nitrogenous extractive matter alluded to in the former lecture. This substance, when separated from the other elements of this secretion, very rapidly undergoes spontaneous putrefaction. If urea, or

uric acid be isolated, either of these substances may be kept, either in a dry state, or in solution, for a considerable time without change. Dissolved in the urine, in company with the extractive, they, however, very quickly ferment—just like the sugar along with yeast: so that this extractive may be regarded as fulfilling the same function in urinous, as the yeast does in vinous fermentation.

Occasionally this extractive matter actually becomes converted into yeast. In the fifth number of the Dublin Hospital Gazette is an abstract of a memoir by M. Bouchardat, in which he describes the manner in which yeast is produced. It has long been known that yeast consists of globules, visible in the field of the microscope, varying in size and form according to the circumstances of their formation. Now, M. Bouchardat shows that the contents of these globules is invariably a nitrogenised substance, approaching in composition to albumen or fibrine, and that this substance in the yeast globules is contained in a membranous envelope. These globules form themselves when any of the albuminous elements are contained in a saccharine solution; and these conditions are present in the urine whenever that fluid contains sugar. Now, in disease, this secretion sometimes contains large quantities of sugar, and, in perfect accordance with the premises, yeast globules, under such circumstances, invariably become formed. But the extractive matter of the urine does not sufficiently approach to the composition of albumen to produce a perfect yeast: the globules thus formed, unless albumen itself be accidentally present, are incapable of exciting the vinous fermentation, instead of which, they produce what is called the viscous fermentation, the products of which are lactic acid and mannite—the sweet principle of manna. The latter, however, has been ascertained by M. M. Boutron and

Fremy, not to be a necessary product; and, indeed, I have sought for its presence in fermented diabetic urine without success: but lactic acid is, under such circumstances, evolved in considerable quantities, and is the cause of *saccharine urine becoming more and more acid by being kept.* Now, this is exactly analogous to what M. Bouchardat has shewn to take place when the brains of adult and young animals are successively employed as ferments in saccharine solutions; in the former case the fermentation which takes place is of a different nature from that which occurs in the latter.

During the process of fermentation the contents of the yeast globules become changed: a slow oxidation takes place, new principles become generated, and they lose their power of instituting fermentation in saccharine liquids. The globules now unite together, one after the other, and true confervoid filaments become formed. These vegetables, thus curiously generated, get the name of *torula*, and, although produced originally without seeds, contain in every cell numerous spores, called collectively the endochrom, and which, it is probable, are capable of re-producing plants similar to the parents, (vide p. 33.)

We may perceive, from the foregoing observations, that diabetic urine, or that which contains sugar, during its fermentation produces yeast, lactic acid, and a vegetable called Torula. That the acid generated under these circumstances is the lactic, I have proved by the addition of oxide of copper and slacked lime, in the manner described by M. Pelouze in a memoir, an abstract of which is given in the 15th number of the journal cited.

Urine which does not contain sugar, forms, during its fermentation, acetic acid. The presence of this acid in putrid urine has been ascertained by M. Liebig. At page 11

I have shewn you that it is from that portion of urinary extractive which is soluble in alcohol that acetic acid is generated in fermentation, and, at the same time, I furnished you with reasons for believing that this extractive, soluble in alcohol, is a combination of a nitrogenous substance with something resembling sugar or dextrine. That grape sugar does not exist in healthy urine can be proved readily enough, but that some of the other varieties of sugar may be present in this secretion seems exceedingly probable; and, indeed, in no other way can we account for the tendency to the production of acetic acid.

It is not only probable that sugar is contained, in some form or other, in the urine, but also in the perspiration, and for a similar reason, namely, the formation of acetic and lactic acids. Ordinary perspiration contains lactic acid, and in the profuse sweats of rheumatic fever, the sense of smell can detect the odour of acetic acid. The sweat also contains ammonia: Mr. Faraday permitted some clean sand, previously destitute of ammonia, to pour across his hand, when, after this brief contact, ammonia could be detected in it. Neither lactic nor acetic acids, nor ammonia, are contained in the blood. That which escapes from the blood to form the secretion of the skin, is its serum. This fluid is chiefly a solution of albumen; the water evaporates; the albumen dries into a varnish that protects the highly sensitive surface, which varnish is called cuticle; but this cuticle must itself decay, and it is most likely from its decomposition that the ammonia and acetic or lactic acids originate.

Albumen is formed in vegetables (from whence all the albumen of animals is derived) by sugar combining with ammonia, and the mixture losing a certain quantity of water and oxygen. Four atoms of sugar and six of

ammonia, losing thirty atoms of water and four of oxygen, can furnish one atom of albumen. If albumen is formed by the union of sugar and ammonia, it is plain that the two latter compounds may be formed by the decomposition of albumen. It is likely that the albuminous cuticle may suffer this waste, and the sugar fermenting as fast as it is generated may produce either lactic or acetic acids. And as with the skin, so with the lining membrane of the urinary passages; these also sweat; their perspiration is, in like manner serous; the albumen, in the same way, cakes into a modification of cuticle, which is called epithelium: and this epithelium in part escapes unchanged, in part decomposes, it is probable, into ammonia and sugar; and the latter by its fermentation generates lactic or acetic acid, according to the nature of the ferment.

The cuticular and epithelial coatings are not, however, mere homogeneous layers; they are composed of nucleated cells, arranged generally in an imbricated manner: and if, as I believe, the elements of secretion proceed from the decomposition of these cells, secretion is only an instance of the general law of nutrition. But for the elucidation of this view, I must refer you to Mr. Bowman's essay on mucous membrane, in the Cyclopedia of Anatomy and Physiology.

Although acetic acid is formed during the fermentation of urine, it does not necessarily on that account acquire an acid reaction; on the contrary, this fluid by putrefaction, except in diabetes, becomes alcaline. This alcalinity is due to the decomposition of the urea. Urea is composed of the radical of carbonic acid (carbonic oxide=C O) and the radical of ammonia (amidogene=N H_2): to convert urea into carbonate of ammonia, it is only necessary for it to appropriate the elements of an atom of water; and inas-

much as urea is the preponderating element in the urine of the mammalia, the carbonate of ammonia which in this manner becomes generated, bestows its characters on the results of fermentation of this fluid, and the product is consequently alcaline. Now, the earthy phosphates which we noted in our last lecture as constituents of the urine of carnivorous mammalia, are rendered soluble by an excess of acid; and this excess being neutralized by the ammonia proceeding from the putrefaction of the urea, these phosphates are no longer capable of remaining in solution, and are consequently precipitated; the phosphate of lime in the form of an amorphous powder, the phosphate of magnesia in combination with ammonia, in crystals, to which are given the name of ammoniaco-magnesian phosphate.

Uric acid, likewise, is apt to ferment; this substance is a compound of urea and a peculiar substance named by Liebig urile; urile is a compound of two atoms of carbonic oxide and one of cyanogen; it differs from oxalic acid merely by having an atom of oxygen replaced by an atom of cyanogen; oxalic acid being

$$=C_2\ O_3\ ;\ \text{urile}=C_2\left.\begin{matrix}O_3\\Cy\end{matrix}\right\}$$

Now, it is clear that, by exchange with the elements of an atom of water, oxalic and hydrocyanic acids are capable of being produced:

$$C_2\ O_2\ Cy+HO=C_2\ O_3\ +Cy\ H.$$

but the hydrocyanic acid seems immediately to react on water, forming formate of ammonia; for cyanogen, you will recollect, consists of two atoms of carbon and one of nitrogen; and formic acid of two atoms of carbon, three of

oxygen, and one of hydrogen ; ammonia consists of one atom of nitrogen and three atoms of hydrogen ; so, if you suppose one atom of hydrocyanic acid to react on three atoms of water, you have only to imagine the nitrogen of the former to be replaced by three atoms of oxygen, and the three atoms of oxygen of the latter to be replaced by the atom of nitrogen, and the result will be formic acid, and ammonia ;—

$$C_2\ N.\ H. + O_3\ H_3 = C_2\ O_3\ H + N\ H_3.$$

Now, the urine of birds we have seen in our first lecture to be principally composed of uric acid ; and, during its putrefaction, oxalic and formic acids, and ammonia, become abundantly generated. This putrefied urine constitutes the manure called *guano ;* and if you refer to the published analyses of this substance, you will find its composition to be chiefly urate of ammonia, oxalates of ammonia, and lime, and certain salts, amongst which formates are capable of being recognized.

The foregoing considerations lead us to perceive that many products proceed from the fermentation of the different elements of the urine. The extractive matters may yield yeast, acetic acid, and ammonia ; the epithelium may give origin to sugar, lactic or acetic acids, and ammonia ; the urea gives rise to carbonate of ammonia : and the uric acid to oxalic acid, formic acid, ammonia, and, it may be, traces of hydrocyanic acid.

But the important pathological fact is, that these decompositions may take place independently of each other, and even while the urine is yet contained within the system. In our last lecture we have seen that in the herbivorous mammalia the urine is discharged alcaline, containing very little urea ; this proceeds from the decomposition of

the urea into carbonate of ammonia within the organism ; and, in disease, a similar chemical change occurs in man. When the human kidney is afflicted with gout, the urinous extractive undergoes the acetous fermentation, and the urine consequently becomes highly acidified : and the uric acid, being liberated from the bases through whose agency it had been dissolved, by the acetic acid produced, precipitates under the form of crystals. In other cases the uric acid alone ferments, and, as a result of its decomposition, oxalate of lime becomes generated.

The products of these several changes become of immense importance in the diagnosis of disease ; and this is the point of view under which they are chiefly interesting to the physician.

LECTURE III.

ON THE QUALITATIVE EXAMINATION OF THE URINE.

I HAVE already described to you the sensible and chemical properties of healthy urine. Let us direct our attention, now, to the characters of this secretion when diseased.

The first thing that attracts your attention, upon proceeding to examine a specimen of urine which you suspect to be morbid, is its appearance ; whether it be colourless, amber, saffron, red, &c. ; whether it be transparent or turbid. You then test it with red and blue litmus papers, alternately, to ascertain whether it be acid in its reaction, neutral, or alcaline. You next determine its density by a specific gravity bottle or an urinometer. And, finally, you set some of it aside, to observe will it deposit a cloud or sediment, or throw up to the surface a cream, or crystallize on the sides of the vessel. The urine which you

thus examine should be submitted to observation as soon as possible after emission : it ought to be collected in a perfectly clean vessel ; if the patient have leucorrhea, or is menstruating, it should be removed by the catheter ; its density should be taken at a constant temperature (60°F.) ; and the test glass in which it is permitted to deposit ought to have a calibre of at least half an inch in diameter.

The deposit from healthy urine consists wholly of epithelium, which appears at first as a light, translucid, flocculent cloud, but settles down at length into a blanched, semi-transparent jelly. When examined by the microscope, this is found to consist of lamellæ, joined several together, the single plates transparent, and furnished with a nucleus usually approached to one margin. In disease the epithelium may be increased in quantity, or may be nearly absent, or may be mixed with other deposits of organic matter or salts.

The specific gravity of the urine is in general dependant upon the quantity passed within a given time. No exact relation between the quantity secreted and the density can be pointed out, because different individuals secrete very different quantities of the solid constituents. But it may be taken as an approximation to the truth, that when the average density is from 1,020 to 1,025, the quantity of urine passed in twenty-four hours is from a pint to two pints and a-half ; when the average density is from 1,015 to 1,020, the quantity is between two and three pints ; and when the specific gravity averages from 1,010 to 1,015, the quantity is from two pints and a-half to four pints. Now, when these relations are not maintained, the chances are, either that the solid constituents of the urine are abnormally increased or diminished, or that some new and

morbid element is added to the urine. Let us suppose that the quantity of urine secreted by an adult man in the course of the day be a pint, and that its density be 1,010, that is probably a case of suppression of urine, and the continuance of such a state would most likely be followed by the ordinary symptoms of that disease. Again, if an adult secreted three pints of urine per diem, whose specific gravity was 1,025, that person's urine might owe its high density to an excessive and diseased secretion of urea, but more probably to the addition of sugar or albumen. These anomalies become much more important signs of disease when the comparison is made between the secreted fluids of the same individual at different periods.

In endeavouring to ascertain the reaction of the urine, by means of blue and red litmus, you should note the alteration, if any, which takes place when a minute's time has elapsed; sooner, the reaction may not have taken place, and a prolonged immersion may deceive, by washing out the colouring matter.

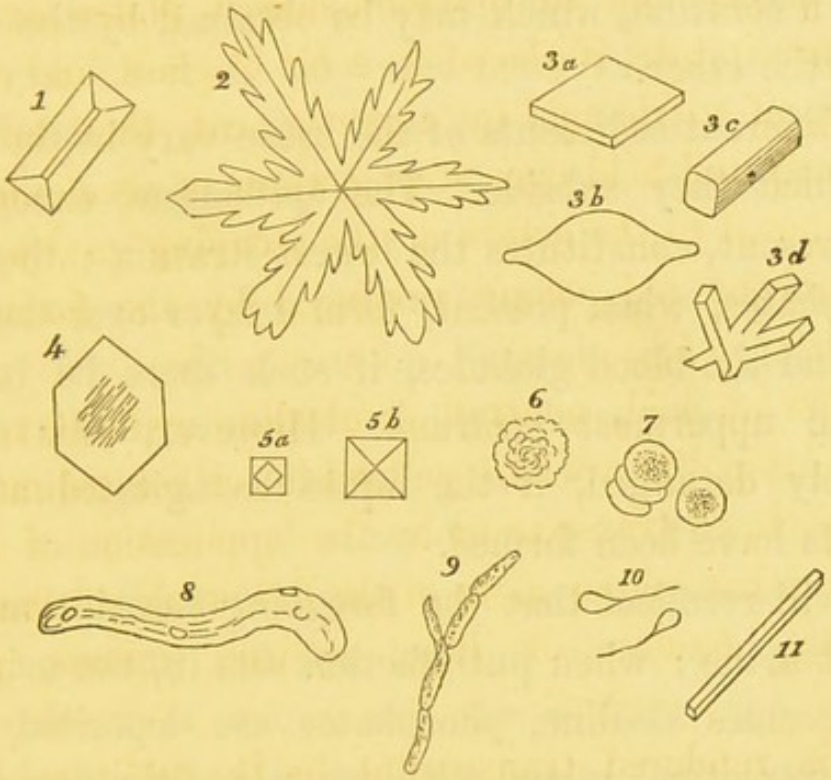
If the urine be very acid in its reaction, and deposit a red, pink, buff-coloured, or white precipitate upon being allowed to cool in a tall glass vessel, the chances are that this precipitate is composed of urates or uric acid uncombined. If, upon pouring out the urine, the bottom of the vessel be stained with an even powdery coating of the deposit, it is likely to be lithates; if hard, crystalline grains adhere to the sides and bottom of the vessel, uric acid is probably present, In the former case the precipitate is usually copious, and dissolves upon the application of heat: in the latter the sediment is generally scanty. The former precipitate presents the appearance of a powder when viewed by the microscope; the latter, that of

yellowish crystals in diamond-shaped plates or prisms. Either precipitate, if placed on a bit of glass, and dissolved in a drop of nitric acid by a gentle heat, then evaporated to dryness, and held over strong water of ammonia, so as to be exposed to the action of the escaping gas, will yield a magnificent red colour, produced by the formation of murexide.

If either an acid, neutral, or alcaline urine be turbid on emission, deposits a white, yellowish, or red sediment, and is not rendered transparent by the application of heat, it contains either one or more of the following substances — phosphates, oxalate of lime, cystine, mucus, pus, or blood.

If it is rendered transparent by the addition of acetic acid, the sediment is composed of phosphates. If dissolved by water of ammonia, the precipitate is cystine. If unaffected by either of the above-named reagents, but dissolved by nitric acid, it is oxalate of lime. If the sediment be whitish, and undissolved by any of these means, the chances are that it is pus or mucus—if red, that it is blood.

It is, however, by the microscope that the discrimination of these different precipitates is most easily and perfectly effected. The earthy phosphates appear as amorphous powders ; ammoniaco-magnesian phosphate is seen under the form of transparent triangular prisms, with the ends cut off as inclined triangles : oxalate of lime appears as octohedral crystals ; cystine as six-sided plates clouded in the centres ; mucous and pus globules as minute, irregularly spherical bodies, with granulated surfaces ; and blood globules as bodies still more minute, of the shape of a shilling, and yellowish colour.



1. Neutral Ammoniaco-Magnesian Phosphate.
2. Bibasic ditto.
3. Different forms of Uric Acid.
4. Cystine.
5. Oxalate of Lime.
6. Mucous Conpuscule.
7. Blood globules.
8. Fibrinous casts of Conduits.
9. Torula.
10. Spermatozoæ.
11. Hippuric Acid.

The phosphates seldom are found as a deposit in urine, unless it be alcaline, neutral, or at least very feebly acid. The other elements which have been mentioned may occur in urine whether acid or alcaline. When mucus or pus occurs in alcaline urine, the globules become in great part destroyed, and the pus or mucus becomes converted into a gelatinous, tenacious mass, whose properties are sufficiently characteristic.

When urine continues turbid or milky after being allowed to stand for some time, this appearance is due to oil, divided as in an emulsion throughout the fluid. This oil can be separated by agitating with ether, in the proportion of one-third the bulk of the urine, and then permitting to settle; when, after a time, the ether will swim at the top, holding

the oil in solution, which may be obtained by the evaporation of the ether.

The different sediments of the urine vary in the facility with which they subside. The epithelium, except when pus is present, constitutes the lowest stratum ; the lithates or phosphates, when present, form a layer over the epithelium ; and the blood globules, if such there be in urine, form the uppermost stratum. However, this order is completely deranged, if the liquid be agitated after the sediments have been formed.

You will recollect that the foregoing description relates to recent urine ; when putrefaction sets in, the urine ordinarily becomes alcaline, phosphates are deposited, and a film of extractive, mixed with crystals of the double phosphate of magnesia and ammonia, forms on the surface.

In the qualitative examination of the urine, it is not only necessary to study the deposits, clouds, and cream, but also to investigate the nature of the dissolved constituents. In the present state of our knowledge, the most important of these soluble elements are bile, albumen, and sugar. The best test for bile that I am acquainted with is that recommended by M. Donne ; to drop, at a short distance from each other, on a plate of glass, urine and nitric acid, when the liquids, gradually spreading, at length mix ; the line where the two fluids come in contact may be examined by an achromatic microscope, and if bile be present, the result of this mutual reaction will be the production of a green colour.

Albumen is easily detected by the joint influence of heat and nitric acid. If urine becomes turbid when heated, and precipitates a white sediment upon the addition of nitric acid, it is most likely to contain albumen. Even under such circumstances, there are certain fallacies, and these I shall endeavour, by and bye, to point out to you.

The presence of sugar is beautifully manifested by Mr. Moore's test. Boil the suspected urine with about an equal bulk of water of potash : if sugar be present, the liquid will assume a deep porter or beer colour, in proportion to its quantity.

You perceive that for the qualitative examination of the urine very few instruments or reagents are requisite. A microscope with a power of 300 diameters, a few test glasses, and phials containing nitric and acetic acids, water of ammonia, and water of potash, with some slips of blue and reddened litmus and an urinometer, are all that are necessary. A few drops of nitric acid added to a given specimen of urine, will throw down the uric and hippuric acids ; after the addition, set aside for some hours, and these acids may by their microscopic characters be readily discovered in the deposit. When the addition of nitric acid causes a whitish curdy precipitate, which does not disappear upon the application of heat, you may be sure that the effect is produced by the presence of albumen. If the nitric acid causes a greenish coloration of the liquid, it shews the presence of bile. Nitric acid is also employed for detecting the presence of urea, but I will describe to you the best method of detecting this substance when we come to the quantitative analysis of the urine.

When ammonia or potash is added to the urine, it causes the precipitation of the phosphates—the phosphates of lime and magnesia being amorphous powders ; and the ammoniaco-magnesian phosphate which is formed by the addition of ammonia, being a different salt from that which I described as being common in neutral or alcaline urine, containing twice the quantity of ammonia, and crystallizing under the appearance of stars with six or eight foliated rays. (See woodcut, p. 33.)

In applying heat to the urine, the best way is to have the liquid contained in a test glass, and to hold the latter obliquely over the flame of a spirit-lamp, so that the heat may first reach the upper part of the fluid : in this way, by comparison with the lower part of the liquid, you can best observe the changes produced.

In a case where there is but one morbid product present, nothing can be easier than the qualitative examination of the urine. It is only when you have a combination of differently morbid conditions, that difficulty arises. I shall now endeavour to point out to you the means of unravelling some of these complicated mixtures.

Suppose there was presented to you a specimen of urine to examine, which was high-coloured, neutral, with a whitish amorphous deposit; that upon the addition of nitric acid and agitation this deposit did not seem to dissolve; and that upon the application of heat, no apparent change took place. The urine in this case would be albuminous, with a deposit of earthy phosphates. The urine did not coagulate by heat on account of its alcalinity; for neutral or alcaline urine will not coagulate by heat, although albuminous; and the coagulation of the urine by nitric acid, would disguise the solution of the phosphates by the same reagent. In this instance acetic acid would dissolve the phosphates without coagulating the albumen ; and nitric acid and heat would afterwards detect the presence of the latter.

Again, suppose a specimen of urine, high-coloured, acid, and depositing a copious powdery sediment, which disappears upon the application of a gentle heat, but upon raising the temperature to ebullition, a copious white and flocculent precipitate is thrown down. The urine in this case would be a highly concentrated specimen, containing a more than ordinary proportion of the earthy phosphates;

nd Schaffner has shown that solutions of the phosphates f magnesia and lime are decomposed at a boiling tempe- ature, sub-phosphates being precipitated. That the phos- hates of the urine are frequently precipitated by ebullition vas first pointed out by Dr. Rees, and it is now a pheno- nenon sufficiently familiar. In this case the addition of a ittle nitric acid, causing the re-solution of the precipitate, vould point out its difference from albumen.

Let us suppose another specimen of urine—high coloured, ransparent even in the cold, and alcaline, which would emain unchanged by the application of heat, but which vould instantly precipitate upon the addition of acetic cid. Such a specimen would consist of a highly concen- rated urine, in which the urates were kept dissolved by an xcess of alcalie, but upon the latter being saturated by an cid, they would instantly precipitate. That the sediment roduced under such circumstances was composed of urates, ould be easily proved by their disappearing upon the pplication of heat.

The foregoing are some of the most common and difficult omplications which you will meet with in practice ; but a ittle experience will soon enable you to detect their true ature.

ON THE QUANTITATIVE EXAMINATION OF THE URINE.

"The analysis of the urine," says Berzelius, "is a problem ifficult to resolve :" and yet men in practice think there s nothing to be done, but to send some two or three ounces f this complex fluid to a chemist, and receive by return of ost an exact estimate of the proportions of every organic lement, as well as of every salt. How to attempt such a rocess, I shall not here enter upon : sufficient it is to say

that it has never yet been perfectly executed ; and that as far as our knowledge of diagnosis and pathology extends, a much less degree of chemical accuracy will be adequate to poise it.

In the following remarks, I shall confine myself to a description of the means of determining the quantities of such morbid products as are desirable to be known for purposes of treatment and diagnosis ; these are sugar and albumen. And the process I shall recommend will be such as, although not calculated to insure critical accuracy, will be easy of performance and sufficient for the practical purposes to which I have alluded.

And first, as regards the determination of the quantity of sugar, I cannot recommend you any direct method of doing this ; in all the processes invented for obtaining diabetic sugar, a large proportional quantity of this substance is necessarily sacrificed ; and when you endeavour to estimate it by the loss which the extract of urine suffers when we destroy the sugar by fermentation, the yeast added to produce this fermentation gives an uncertain surplus to the remaining extract ; whose amount is on the other hand diminished by a variable quantity of urea being lost as carbonate of ammonia.

The method which I recommend you to pursue is to determine the quantities of salts and urea, and from thence to calculate the amount of sugar and extractive present.

Dr. Christison has calculated that for every unit added to the density of water, taken as 1000, the quantity of solids in solution is equal to 2.33. Thus, if the specific gravity of a specimen of urine be 1,010, we can find the amount of solid matter in solution by the following equation :—

$$2.33 \times 10 = 23.30:$$

f the density be 1020,

$$2.33 \times 20 = 46.60.$$

ill afford you the sum of solid constituents.

Now the analysis of urine, furnished by Berzelius, to which I drew your attention in the first of these lectures, gives 67 grains of solid matter in the 1000 ; and as urine f the density of 1029, according to the foregoing formula, gives

$$2.33 \times 29 = 67.57.$$

ve may regard the specimen analysed by him as of this pecific gravity. These 67 parts of solid constituents consisted of 30.10 of urea, 18.14 of extractive matter and organic acids, and 18.76 of inorganic salts. In a similar case Dr. Christison found the quantity of urine excreted in 24 hours to be thirty-four ounces avoirdupoise. So that ve have here a series of data by which we can always calculate, with a tolerable approach to accuracy, the composition of a specimen of urine not containing any unusual constituent.

Thus, if we suppose the density of a given specimen to be 1012, the amount of solid constituents it contains in the thousand grains is—

$$2.33 \times 12 = 27.96 \text{ grains.}$$

And if the relative proportions of urea, extractive, and salts be the same as in the specimen examined by Berzelius, these 27.96 grains consist of 12.561 grains of urea, 7.569 of extractive matter and organic acid, and 7.83 of inorganic salts. Now, although it is not true that there is any constant relation between uric acid and urea, hippuric acid and urea, colouring matter and urea, or

extractive matter and urea—in fact, between the urea and any one of the other organic matters of the urine, I find, by examining a considerable number of analyses made by myself and others, that the sum of these organic matters maintains a very constant relation to the quantity of urea, and in the proportion ascertained by Berzelius, namely, of about 30 : 18. So that by ascertaining the quantity of urea present in healthy urine, you may with great probability infer the quantity of other organic matters.

Unhappily for the utility in practice of the foregoing formula, the same rule does not apply to the inorganic salts, which are very liable to vary ; so that it is necessary, in every instance, to determine the amount of these salts present, in any given case. How to do this I shall tell you further on; but, for the present, I wish to shew you that, in an ordinary specimen of urine, you will be enabled to arrive very nearly at a knowledge of the quantitative constitution, as far as is required for practical purposes, by ascertaining the specific gravity, and then determining the quantities of urea and inorganic salts. For suppose that the specific gravity be 1012, we have seen that the solid constituents will be 27,96 in the thousand ; and, furthermore, suppose that, by the methods to be afterwards described, you ascertain that the inorganic salts are equal to 5, and the urea to 14,36 ; then the sum of these will be 19,36, which subtracted from 27,96 will give you 8.61 of extractive matters and organic acids ; or you can ascertain the same thing by knowing that the constant proportion of the latter constituents to the urea is as 18 : 30, so that you can find the sum of organic extractives and acids by the following equation (27,96—5 = 22,96)

$$\frac{22.96 \times 18}{18+30} = 8.61$$

Now, let us suppose that you did not know the density f this urine, but merely ascertained that it contained 5 rains of inorganic salts, and 14.36 of urea in the thou- and grains, it is quite evident that, by the foregoing quation, you could ascertain that the extractive matters nd organic acids amounted to 8.61 grains ; these numbers dded together afford you 27.96 grains of solid constituents ontained in 1000 grains of the specimen, and

$$\frac{27.96}{2.33}=12$$

So that you can by these means ascertain that the density f the urine in this case is 1.012.

But let us go a step further, and imagine that the speci- nen you were called on to examine contained sugar in ddition to its ordinary constituents, and that its density, scertained by the urinometer, was 1050, then, by experi- nentally determining the inorganic salts and urea, and rom thence calculating the organic extractives and acids, ou can find out, as we have seen, what the density would e if it did not contain sugar ; by subtracting this from the ctual specific gravity and multiplying the difference by 2.33, you get the actual quantity of sugar present.

$$1050-1012\times2.33=88.54.$$

Thus, you may perceive, by simply taking the specific gravity and ascertaining the quantities of urea and inor- ganic salts present in diabetic urine, you can make out by a little calculation an analysis sufficiently approximating for practical purposes to the truth ; and in a case such as we have supposed, you might write down the composition of the specimen in the following manner :—

Water, ...	883.49
Urea, ...	14.36
Organic extractives and acids, .	8.61
Inorganic salts, . . .	5.00
Sugar, ...	88.54
	1000.00

It is now necessary for me to tell you how to determine the quantities of inorganic salts and urea. To find out the proportion of the former, all that is necessary for you to do is, to evaporate a known weight of the urine to dryness, heat the residue in a porcelain crucible, over a spirit-lamp with circular wick, till it ceases to give off fumes; then mix it thoroughly with about half its weight of red precipitate, and subject it to a full red heat; and permitting the ashes to cool, collect them carefully and weigh them.

To determine the urea, evaporate a known weight of the urine, in a water-bath, to a syrupy consistence; then dissolve in this, at a temperature of about 110°F., as much oxalic acid as it will take up; allow the liquid to cool, and hasten the refrigeration by a cooling mixture; crystals of oxalate of urea will form, which permit to drain, by letting them lie on a piece of glass placed obliquely; by the evaporation of the mother liquid and again cooling, an additional crop of crystals can be obtained: when well drained, dissolve in water, and mix with as much powdered chalk as will convert the liquid into the consistence of pap; throw this on a filter, and wash by repeated effusions of water: you thus separate the oxalic acid, as oxalate of lime, which remains on the filter, while the urea passes through in solution; evaporate the latter carefully in a water-bath to dryness, and weigh the urea when cold.

I prefer this method of determining the urea to that of converting it into the nitrate, inasmuch as nitric acid,

when added to extract of diabetic urine, reacts on the sugar, causing the evolution of red fumes, which in turn decompose much of the urea.

Recollect that I recommend the foregoing method of analysing diabetic urine, not because it is the best in a chemical point of view, but because it is the easiest, requires least time, and gives results sufficiently accurate for prognosis and treatment.

We must now turn our attention to the quantitative examination of albuminous urine: and for this purpose all that is necessary is to ascertain the specific gravity, and then determine the proportion of albumen. The latter object can be readily attained by evaporating a known weight of the urine, by means of a water-bath, to dryness, and then washing very well the residue with boiling water, acidulated with a few drops of hydrochloric acid; lastly, dry and weigh. Every 2.33 grains accounts for an unit in the density, so that it is easy to calculate the deficiency of natural constituents. Thus, suppose the specific gravity to be 1020, that the quantity passed in twenty-four hours was two pints; these conditions are within the limits of health. But let us suppose you found 10 grains of albumen in the thousand; this would account for nearly $4\frac{1}{3}$ of the density, which, if no albumen were present, would therefore be $1015\frac{2}{3}$; and a urine of the latter specific gravity ought, normally, to be secreted in greater quantity; in such a case you would be justified in concluding that the solid constituents of the urine were secreted in deficient quantity.

In all cases of quantitative examination of the urine, recollect that the quantity secreted during twenty-four hours is an indispensable element for all practical purposes.

LECTURE IV.

PATHOLOGY OF URINARY DISEASES.

THE usual method of describing urinary diseases is to tell the different modifications to which the urine is liable, and then to enumerate the pathological causes which may give rise to each peculiar form. This method appears to me very objectionable; the changes which the urine is liable to suffer from disease constitute symptoms of the disease, and, however valuable in that point of view, are not entitled to be regarded in a higher light. Nosologists at one time employed symptoms as a mode of classification, and even at the present day, when ignorant of the lesional cause, symptoms are used for the segregation of particular diseases; but in these cases all the symptoms are taken into account, and in the diseases of no other apparatus except the urinary, has it ever been proposed to found a classification upon the alterations of a single function. Nothing could justify such a departure from ordinary pathological rules, except the impossibility of finding other data for classification; but we are not reduced to this necessity with respect to urinary diseases; in the greater number we are acquainted with the presiding lesions, as well as with numerous symptoms derived from other sources besides the nature of the urine; and in the few diseases in which we are unable to determine the primitive lesions, we have a sufficient number of symptoms, both local and general, for every nosological purpose.

This method of classifying urinary diseases by the modifications of the urine is, however, not only unphilosophical, but is extremely inconvenient in practice, and is liable to lead to erroneous views of disease. How cramped in his diagnosis, and uncertain in his treatment, would the phy-

sician feel himself if accustomed to regard pulmonary diseases only through the medium of the expectoration ; and we can scarcely picture to ourselves the amount of obscurity and confusion of mind which would result from his sitting down to prescribe for a rusty sputa diathesis, or a mucous expectoration diathesis. Yet this is what, until very lately, he was called to do with respect to diseases of the urinary organs ; there was the lithic acid diathesis, and the phosphatic diathesis, and many other groups of ill-defined diseases, named after single symptoms, themselves sometimes only accidental to certain remote affections, at others depending upon appreciable and alleviable local causes.

To Sir Benjamin Brodie and M. Rayer are due the credit of endeavouring to rescue the diseases of the urinary organs from this discreditable and anomalous position : they have sought to connect the functional disorders with the organic lesions upon which they depend, and, where this cannot be done, at least to define the groups of symptoms, to which may be philosophically given the name of a distinct disease. This is the course which I shall endeavour to imitate in the present lecture.

In the same way that in studying diseases of the lungs or heart, it is indispensable to form correct ideas with respect to the structural and relative anatomy of these organs, so is it with the diseases of the urinary apparatus. Within the limits of a lecture such as the present, I cannot enter into the details which would be otherwise desirable ; but I may at least find room for a sketch of their organization, necessarily superficial, but sufficient to enable you to comprehend the lesions afterwards to be described. The urinary apparatus in man consists of two conglomerate glands situated in the lumbar regions, nearly symmetrical, and emptying themselves by excretory ducts,

called ureters, which terminate in a common membranous bag placed behind the pubis, and which is called the bladder; this latter evacuates the liquid conveyed to it by the ureters through a tube called the urethra. When a longitudinal section of the kidney is made, the ureter is found to dilate within its substance into a cavity, from which branches ramify in an eccentrical manner in different directions; the principal cavity is called the pelvis, and its branches are named calyces. The solid portion of the kidney is manifestly composed of two distinct structures; an organization of a granular appearance crossed by striæ, at the circumference, and which is called the cortical portion; and bundles of straight tubes converging into cone-shaped masses, whose apices are directed towards the calyces already referred to; this is called the tubular portion; between these cone-shaped masses of tubular substance, the cortical portion dips, so as to fill up the spaces between them. In the fœtal state, the cortical portion being little developed in proportion to the tubular, the kidney appears to be divided into a number of distinct lobes; but you are not to suppose that, because a kidney appears lobulated, it is therefore but little developed; because in the otter, seal, and whale, whose kidneys are highly organized to compensate for the defective performance of the cutaneous functions, they are very much lobulated: and the same is the case with birds, fishes, and reptiles.

In accordance with the usual structure of glands, Muller has demonstrated that the apparently granular cortical portion is actually composed of a convoluted congeries of minute tubes, lined with capillary blood-vessels; so that when we ascend from the ureter through its funnel-shaped communication with the kidney, we find it

to divide and subdivide into tubes still more and more minute in the substance of the organ, until the ultimate ramifications terminate in closed extremities. The pelvis of the ureter communicates with the infundibula ; the latter subdivide into the calyces ; each calyx receives the orifices of numerous tubes belonging to the cone-shaped masses of tubuli already described, and which are designated the tubuli uriniferi ; and each of these tubuli serves as the excretory duct to a vast number of tortuous tubules which we shall call the urinary conduits, and which by their aggregation form the cortical portion of the gland.

Bowman has particularly studied the structure of these urinary conduits : he finds that after pursuing a devious course through the cortical substance, which, as we have said, is made up of their mutual interlacements, each contracts into a narrow neck, and then expands into a minute cyst, in a like manner to the ultimate ramifications of the bronchial tubes, which you are aware terminate in the pulmonary vesicles : but, unlike the pulmonary vesicles, each of these renal cysts contains a little ball composed of interwoven capillary blood-vessels, which was first perceived by the celebrated anatomist Malpighi, and which from him has been since called " the glandule of Malpighi," The urinary conduit is lined, we have already stated, with a plexus of capillary vessels, and coated internally with a thick layer of epithelium ; the epithelial scales that line the narrow neck being furnished at their borders with numerous vibratile cilia, the only part of the urinary track where these bodies are found. My friend Dr. Gerlach has thrown additional light on this department of structural anatomy. He has ascertained that the little cysts containing the Malpighian bodies are really diverticula, communicating each by a pervious neck with a urinary conduit ;

and the latter, instead of terminating in the cyst, is actually a loop, which returns and again opens into the urinary tubule.

The manner in which the blood-vessels are distributed throughout the kidney is peculiarly worthy of your consideration. The renal artery arising from the aorta divides into five or six branches, previously to entering into the substance of the kidney, and again, as soon as it reaches the apices of the cones, subdivides into numerous straight vessels, which pass between the tubuli uriniferi towards the cortical substance ; as soon as they arrive at the latter, a further subdivision takes place, some ramuscules go to nourish the basement membrane and capsule of the kidney, but the greater number communicate with the little balls of convoluted capillaries which I have described as the glandules of Malpighi ; from each of these glandules another vessel of about the same calibre is given off, which, joining with similar ones from other glandules, unite to form the plexus that surrounds each urinary conduit ; from these plexuses arise the radicles of the renal veins, so that the arterial blood, before it arrives in the renal vein, has to pass through two sets of capillary vessels, one constituting the glandules of Malpighi, the other the plexuses lining the urinary conduits ; and the communicating vessels between these two sets of capillaries are, as Mr. Bowman says, so many portal veins in miniature, commencing in capillaries and terminating in capillaries.

The above is the nature of the renal circulation in the mammalia ; in the oviparæ, however, there is a marked difference ; in the latter class of animals, the plexuses that supply the conduits only in part derive their blood from the Malpighian glandules, getting it chiefly from a large vein belonging to the general system, and into which the

fferent vessels from the bodies described by Malpighi mpty themselves. The fact that the urine of birds, fishes, nd reptiles is secreted from venous blood, was long since oticed by Jacobson (Bulletin de la Soc. Philom. 1813. J. J. H. Nicholai, Disquisitiones circa quorundum animalium enas abdominales præcipue renales. Berlin 1823.)

The structure of the Malpighian bodies indicates their unction: composed of numerous convoluted capillaries, ndividually as large, and collectively many times larger, han their afferent and efferent vessels, the blood must low through them very slowly, while the nearly naked ondition of these capillaries permits the copious exudation f watery elements, the escape of which into the conduits s facilitated by the vibratile cilia of the neck. Bowman has furnished arguments for believing that the solid constituents of the urine are principally secreted by the plexuses lining the urinary conduits and we are thus enabled to understand why it is that the watery and solid constituents of the urine should be totally independent of each other. Again, the solid urine of the oviparæ is well accounted for, by the fact that only a fraction of the blood contained in the plexuses from whence the solid constituents are given off has previously passed through the glandules which yield the watery portion.

Time will only permit me to add, in connection with the anatomy of the urinary organs, that the excretory passages are lined with mucous membrane, consisting of a capillary web, coated with epithelium, and that the kidneys themselves are enveloped by a fibrous capsule, which is usually embedded in a considerable quantity of adipose tissue.

When investigating diseases of the urinary organs, it is just as necessary to distinguish the anatomical elements affected, as in diseases of the lungs or heart: how absurd,

in the present day, would it appear to confound bronchitis with pneumonia, or either with pleurisy; yet, until the appearance of Rayer's admirable work, it was not considered necessary to separate inflammations of the parenchymatose substance of the kidneys, from those of the urinary passages; but diseases of the different portions of the urinary apparatus are sufficiently characterized to be recognized as separate affections: and confusion and error will arise in their diagnosis and treatment, if their distinctions be disregarded.

The parenchymatose substance of the kidneys, including their cortical and tubular portions, is liable to be attacked by the several lesions which are recognized in other organs. It may be the seat of ordinary inflammation, whether acute or chronic (nephritis); it may be attacked by gout or rheumatism; it suffers an alteration in essential fevers similar to the blackish congestion and softening which other organs are liable to in these disorders; tubercles may be deposited in it; cancerous growths of different kinds may select it to develope themselves in: abscesses may form within its structure; or, from the obstruction of its passages, the tubuli or conduits may become dilated into enormous cysts. I shall delay you, very shortly, on each of these lesions.

Acute nephritis is pathologically characterized by considerable vascularity. You will often, however, find the kidneys very much congested after death, where no lesion has existed during life; this occurs when the death has been by syncope, and considerable putrefaction has taken place previous to the autopsy: when the death is by syncope, the arteries contain blood; and when putrefaction takes place, gases are rapidly generated in the large vessels, driving the blood down into the capillaries. I

have frequently, from these causes, seen the kidneys nearly black from extreme congestion.

In chronic nephritis, the organ is usually more or less atrophied, its cortical substance absorbed in patches, so as to bring the external tunic into contact with the base of the cones, and is usually discoloured.

In the renal complication of contagious fevers, the kidney is blackish, extremely congested, and softened, and appears to be infiltrated with a gelatinous exudation.

In rheumatism and gout of the kidney, the organ is generally somewhat atrophied, and lobulated as in chronic nephritis ; it is indurated, and patched externally between the cortex and the capsule with adhesions formed of exuded fibrine.

I have rarely met with tubercles in the parenchyma, and always in connection with tubercular depositions elsewhere. The tubular substance appears to be the favourite site of these deposits, and I have seen three instances in which all the cone-shaped masses of tubuli in the kidney were replaced by tubercular excavations, without any tubercles existing in the cortical substance.

I have never seen cancer of the kidney except when this degeneration existed to a considerable extent in other abdominal organs ; but I have frequently observed a mottled appearance of the cortex, especially deep seated between the cones, in cases of abdominal cancer, which may be an incipient stage of this affection.

Dr. Stokes has remarked that abscess is rare in glands with free excretory ducts. In parenchymatose organs without excretory ducts, such as the brain, abscess is of frequent occurrence ; in glands where the escape of secretion takes place through comparatively minute tubes, such as the liver, abscesses are also commonly met with ; but

when the communication with the exterior is very facile, this accumulation of retained pus is rare. In the latter category are the lungs and kidneys, and we accordingly find that true abscesses of the parenchyma of the kidney are of very rare occurrence. When speaking of the diseases of the urinary passages, I will shew that which has been mistaken for renal abscess. For the present it is enough to say that occasional suppuration does take place in the cortical and tubular substances, producing minute deposits of pus, sometimes very numerous, but seldom larger than a grain of shot.

An affection closely simulating abscess of the parenchymatous substance is sometimes met with. It consists in a dilatation of one or more tubuli or conduits, producing a cavity the walls of which may secrete pus. The pressure of the cysts thus produced may cause the absorption of the other structures of the organ, so that the kidney may seem to be replaced by three or four large bags containing pus situated at the extremity of the ureter. Or the contents may vary very much in their nature; they may seem to be watery or gelatinous. When small and confined to dilated conduits in the cortical substance, they are usually, but erroneously, called hyatids.

I have told you that the urinary conduits are lined by epithelium; it is together with this epithelium, itself an albuminous exudation, that the solid elements of the urine permeate through the walls of the capillaries, which form the interior plexus; and it is from between the scales of this epithelium that these solid constituents are washed out by the watery current flowing from the Malpighian glandules. There is a disease, however, in which the albuminous element of the blood no longer exudes to form solid scales of epithelium, but continues liquid after its

secretion, and dissolves in the water of the urine, or becomes organized into plastic lymph corpuscles, and either chokes up the trajet of the conduits, whose form they collectively assume, and presents to the eye the appearance of whitish or yellowish granulations, mottling the cortical substance, distending it, and thus producing pressure upon the tubuli uriniferi, which in time become absorbed ; or, as frequently occurs at the commencement of the disease, distinct tubes of false membrane, miniature analogues of those sometimes expectorated in croup, are separated from the conduits and discharged with the urine, (Simon). This is the form of renal disease usually named after Dr. Bright, and to which so much interest has been latterly attached.

Mottled or granulated kidney frequently commences with a true nephritis ; it is doubtful whether in every instance there is not an inflamed condition of the lining membrane of the conduits as its immediate cause. The kidney being pale after death is no proof of the absence of inflammation during life. Such paleness may be partly accounted for by the whitish colour of the granulations ; and partly by the nature of the death, which in these cases is almost always by apoplexy ; and when a cessation of the brain's functions is the cause of death, the arteries are invariably empty, and those organs which, like the kidney, are principally supplied by arterial blood, will consequently be found comparatively anemic. Nor is inflammatory redness always a necessary preliminary to inflammatory exudation ; Dr. Graves has shewn that in scarlatina without eruption, copious desquamation of the cuticle takes place, as well as when the skin had been previously highly vascular ; and the lamented Dr. Houston and I found the interior of the lateral ventricles coated with plastic lymph corpuscules,

while the lining membrane was of a chalky whiteness. Membranes naturally secreting cuticle invariably pour out either albumen or fibrine when acutely inflamed; thus we have a glairy, transparent albuminous sputum in acute catarrh; false membranes forming on the interior of the trachea and larynx in croup; and the progress of pathology is daily demonstrating that the nature of the exudation is the best criterion of inflammation. (See Bennet on inflammation considered as a process of anormal nutrition; and on cerebral softening.) I am led, therefore, to consider the fact of the lining membrane of the urinary conduits pouring out organizable lymph in Bright's disease, as a sufficient proof of its being in a state of inflammation.

The remote cause of this perverted function of the urinary conduits is a suppression of the cutaneous secretion, and consequently a vicarious activity of the renal functions. This suppression of the cutaneous functions may be produced either by the direct application of cold or other sedative agents to the surface, or may be the consequence of a revulsive stimulation of the urinary organs through prolonged intemperance. We owe this suggestion, as to the remote cause of Bright's disease, to Mr. G. Ross.

The urinary conduits being choked by organized albumen, their ordinary functions are interfered with; the water can no longer escape from the Malpighian bodies, nor can the solid elements exude from the lining capillaries of these conduits; the consequence is, that the water accumulates in the system, producing dropsy, and the urea, no longer permitted to escape, poisons the blood, and gives rise to the symptoms of simple apoplexy.

But the albumen separated by the urinary conduits from the blood does not always escape in its original form. In one variety of disease it undergoes the decomposition which

I described to you in page 25 ; it becomes resolved into sugar and ammonia. The saccharine solution thus produced acts by endosmose on the capillaries, increasing their watery exudation : and thus becomes established the disease designated diabetes mellitus.

The close connexion that exists between diabetes mellitus and Bright's disease must strike every observer. In both there is suppression of the functions of the skin ; in both there is a new and unusual element added to the urine ; in both there is a diminution of the albumen of the blood ; in both there is a tendency to the formation of oil in the serum and urine.

But sugar has no tendency to organize ; and in this their chief difference in results resides. No obstacles to the escape of urine from the urinary conduits arise in the course of diabetes, and therefore all the elements of this secretion are eliminated in the usual or even in increased proportion.

The relation that exists between Bright's disease and diabetes occasions a liability to alternation between these diseases. The urine in the course of diabetes occasionally becomes albuminous ; and then, as M. Rayer has shewn, there is danger of dropsy supervening. Occasionally, however, the presence of albumen in the urine during this disease is an evidence of a return of the proper function of the urinary conduits, and of their tendency to secrete a normal epithelium ; and, during convalescence from diabetes mellitus, I have sometimes found a shreddy fibrinous deposit similar to the debris of false membranes, indicative of the same result, but sometimes also shewing the supervention of inflammation.

Albumen, developing itself under the form of sugar, is under the influence of a vital condition of the urinary con-

duits, the opposite of that which exists in Bright's disease. In the latter, the lining capillaries are in a condition of acute inflammation; in the former, they are in a state of atony, the converse of irritation, and requiring a corroborant treatment to restore them to their healthy functions. All the remote causes which produce diabetes mellitus are of an exhausting nature; onanism, spinal injuries, standing with the back constantly exposed to the torrid furnace of a glass-house, are all of this nature; and it is when this asthenic condition becomes replaced by acute inflammation, that there is danger of diabetes mellitus lapsing into mottled kidney.

Some pathologists imagine that granulated kidney approaches in its nature to cirrhosis of the liver or lung. But cirrhosis is essentially a disease of the fibrous basement membrane. By inflammation and, it may be, the exudation of lymph, this membrane contracts and produces atrophy of the other elements of the gland: but in Bright's disease it is the lining of the terminal tubes that is inflamed; the exudation of lymph takes place chiefly internally in place of externally, so that the nature of the disease is absolutely different. In accordance with the ingenious idea of Dr. Evans, I look on cirrhosis as the result of rheumatism attacking a gland, (see *Dublin Hospital Gazette*, No 3,) and consequently regard the disease of the kidney, which is strictly analogous to cirrhosis of the lung or liver, to be rheumatism of the first mentioned organ; the pathological results of rheumatic inflammation of the kidney are atrophy and induration. As the kidney is not composed of lobules like the liver, you could not expect that the contraction of the basement membrane should produce similar results; and, indeed, the manner in which the urinary conduits are supplied with blood precludes the possibility of interference

with the circulation being in any considerable degree produced by contraction of the basement membrane.

I may in this place allude to the late revival of a pathological notion, long prevalent in Germany, that in the large, flabby kidney of Bright, the disease primarily consists in a morbid deposition of fat. In this variety of mottled kidney there is indeed always a considerable quantity of oil in the kidney, just as there is oil in the serum and in the urine; but these are the effects, not the causes, of the disease.

The lining membrane of the urinary passages of the ureters, the bladder, and urethra, is subject to inflammation, sometimes acute, sometimes chronic. When acutely inflamed, the natural epithelial secretion becomes replaced by albumen, and the urine becomes consequently albuminous. When the inflammation is of an asthenic nature, the albuminous exudation at the moment of its secretion becomes imperfectly organized into pus globules, and the urine becomes, therefore, purulent. Pus in the urine has not always, however, this source. It frequently arises from abscesses communicating with the urinary passages, or from dilated and suppurating tubuli or conduits in the kidneys themselves. In these cases, however, the pus is in much larger quantity, and intermittent in its presence, being sometimes abundant, sometimes entirely absent. I have already told you that pus acts as a ferment to the urine, which is, therefore, when this secretion is present, peculiarly apt to ferment; and the alkali generated reacting on the pus, destroys the globules, and causes their contents to cohere into a glairy, tenacious jelly.

In ancient catarrhs of the vesical mucous membrane, this organ frequently secretes an abundance of earthy phosphates, which, mixed with pus, constitutes a mortar-like deposit from the urine.

In sub-acute inflammation of the mucous lining of the neck of the bladder or urethra, globules exactly similar in appearance to those of pus are found in the urine. These are called mucous globules, and differ from pus in not being accompanied by a serous secretion, which is always the case with the latter, but by a liquid resembling a solution of gelatine. In gonorrhea, the mucous membrane is not necessarily the seat of ordinary inflammation, although very apt to be complicated with it; and it is useful to know that we can always recognize this complication by the urine becoming albuminous. It is obvious that the urethra must be washed by the first gush of urine of its purulent contents, before we collect the portion which, in this disease, we wish to examine for albumen. But Dr. Rees has lately pointed out another source of fallacy in this case; for he has ascertained that after the use of copaiba or cubebs for some time, the urine contains a vegetable matter coagulable by nitric acid.

Hæmorrhage may take place from any part of the urinary tract. After wounds or lacerations of the kidneys, the urine frequently appears to be replaced by pure blood; breaches of the mucous surface from external injury, or the passage of calculi, may produce a sanguinolent urine; this secretion is frequently tinged with blood in tubercular and cancerous diseases of the urinary passages.

But besides these accidental sources of hæmorrhage, there are other varieties of hæmaturia which proceed from causes more profound. Blood may spontaneously escape either from the kidney or the lining membrane of the bladder, and become mixed with the urinary secretion. The only instances in which it proceeds from the bladder, except when the result of mechanical injuries, or tubercular or cancerous ulcerations, are where its secretion is vicarious of other hæmorrhagic discharges. Thus, hæma-

turia may be vicarious to the menses, hæmorrhoidal losses, or even periodical attacks of epistaxis.

When neither accidental to injuries or diseases of the urinary passages, nor vicarious, the hæmorrhage always proceeds from the kidneys. In this case it may be constitutional, as in purpura and scurvy; or endemic, as in certain tropical countries such as the Mauritius and Brazil, when it commonly continues until puberty; and sometimes even then only changes its form, persisting as an invisible variety, although its presence may no longer be proclaimed by the colour of the red particles; for you are aware that the colour of blood is due to the red globules which, when removed, leave the more essential constituents under the form of a nearly colourless liquid, called the liquor sanguinis, which is a solution of fibrine in serum; and if this liquor sanguinis be permitted to rest, the fibrine coagulates and is capable of being separated from the serum—a mere albuminous solution. So, as M. Rayer has shown, hæmaturia may consist in the escape of all the elements of the blood, or of the liquor sanguinis, or simply of the defibrinated serum. And this is not peculiar to hæmaturia; for you may also have a serous epistaxis or hæmoptysis; and I have met with instances of pulmonary solidification, in which, instead of the usual syenitic appearance, the fibrine solely was poured into the air-cells, constituting what might be called a white hepatization.

In the endemic form of hæmaturia, the urine may continue after puberty highly albuminous, although of a normal straw colour; or it may contain all the elements of the liquor sanguinis, and it will then, from the presence of fibrine, spontaneously coagulate. In the latter case it is apt to contain a large quantity of oil intimately mixed, which gives it a white colour. This remarkable urine

frequently contains such an amount of these elements, as to become converted upon resting into solid jelly; it is called chylous urine by Dr. Prout.

Chylous urine has no tendency to produce granular degeneration, because the albumen or fibrine, not being secreted under the influence of inflammation, has no tendency to organize.

Inflammation of the kidneys is frequently accompanied by an escape of blood globules; thus the urine in acute nephritis, and in the early stages of Bright's disease, frequently contains blood.

Besides the constitutional, endemic, and inflammatory varieties of hæmaturia, sporadic cases of a non-inflammatory or constitutional nature frequently occur. The causes of these essential hæmaturias are often very obscure.

Before terminating the list of urinary diseases, we must allude to those that depend on lesions occurring in the neighbourhood of the urinary organs. I have frequently been enabled to trace affections of the ureters to irritated states of the ascending or descending colon. Abscesses in the pelvis or loins often, likewise, influence the nature of the urinary secretion. An abscess in the cellular tissue, external to the kidney, may communicate by fistula with the urinary passages, as in the case described by Dr. Hutton at the Pathological Society, and reported in the Eighth Number of the *Dublin Hospital Gazette*. In the Fourth Number of the same journal, you will find some admirable remarks by Dr. O'Ferrall, on the bursting of pelvic abscesses into the bladder.

I have, in the foregoing observations afforded you a rapid, but necessarily imperfect, view of the pathological causes of the different modifications of the urinary secretions. For more minute details, I must refer to the magnificent monograph and atlas by M. Rayer.

LECTURE V.

ON THE DIAGNOSIS OF URINARY DISEASES.

Nervous affections of the urinary organs.—It is well known that mental agitation will produce an increased secretion from the urinary organs. In a similar manner we find nervous influence in hysteria to cause either an excessive secretion, or, on the contrary, suppression of the urine. It is, in these instances, the quantity of the watery element which is principally modified. In the disease called diabetes insipidus, the water of the urine is frequently excessively increased, so that the specific gravity of this secretion becomes reduced to a point little above the density of distilled water. Whenever this is the case, we may be sure that there is an enfeebled or semi-paralysed condition of the renal nerves. But, just as pain is an approach to anesthesia, and convulsion or spasm to paralysis, so is this excessive watery secretion allied to total renal suppression. Thus a very violent mental shock may give rise to a complete cessation of the urinary functions. In this case, the chances are that the solid constituents being formed in the usual proportions, but not being enabled to escape, from the absence of water to dissolve them, will be absorbed by the blood, and produce cerebral symptoms. I have seen a case, however, in which the respirations diminished in frequency at the same time that the urine was suppressed: the waste of the tissues, from the want of oxygen, was so much diminished, and the consequent necessity for the elimination of urea and uric acid so far abated, that although the suppression of urine continued for seven days, no cerebral symptoms intervened. I think it may be laid down as a law, that in cases of renal suppression, the ten-

dency to head symptoms will be found in a direct ratio with the frequency of the respirations.

Neuralgia of the ureters may be diagnosed by the existence of severe pains along the course of these ducts, together with the retraction of the corresponding testicle, and pain along the inside of the thigh, without any appreciable alteration of the *urinary secretion.*

Irritation of the urinary organs.—Irritation of the kidneys produces diminution of the watery part of the urine, without alteration of its solid constituents. The consequence is, that the water not being any longer sufficient to hold in solution the super-lithates, these salts deposit according as the liquid cools. Irritation of the kidneys is generally secondary to inflammation of some distant organ, or in connection with a condition of general fever. A deposit of lithates is not, however, always dependent upon renal irritation ; it may proceed from a nervous diminution of the watery element, as in dyspepsia ; a vicarious secretion from some other organ, as in profuse sweating, diarrhæa, dropsy, &c. ; or from an actual increase in the quantity of super-urates, as in rheumatism.

In irritation of the mucous passages, the epithelium is thrown off in unusual quantities : the presence of an excess of epithelial deposit, is therefore an evidence of this irritation either secondary or primary.

The urine is never copious and transparent when cold, if urinary irritation exists. The presence of this kind of urine is valuable, therefore, in a diagnostic point of view, where it is desirable to distinguish between a hysterical and inflammatory affection of any organ. And the same urine leads to an unfavourable prognosis in essential fevers, as it demonstrates a want of equality in the operation of the morbid cause.

Acute Nephritis.—This inflammation is characterized by pain and tenderness in one or both renal regions, together with a scanty and neutral or alcaline urine. The urine frequently contains a little blood. The pain is very variable in extent and violence; it is more profound than muscular pain; greater posteriorly than anteriorly; the best way to detect the tenderness is to place one hand anteriorly and another posteriorly, on the lumbar region, when, upon making pressure, the patient will quickly and involuntarily bend backwards to avoid the pain produced. Recollect that in nephritis there need not necessarily be any pain along the course of the ureter, or inside of the thigh, nor need there be retraction of the testicle. Recollect also that motion of the trunk and heat applied to the surface often increases the pain.

The amount of fever is very variable; it is often remarkable for the violence of the rigors, and their tendency to become renewed. Vomiting is also a frequent symptom. The fever may be either inflammatory or typhoid. Head symptoms sometimes present themselves at the commencement; generally towards a fatal close. It is not uncommon for the urine, diminished or suppressed during the progress of the disease, to become copious and acid a short time before death.

Acute inflammations of the kidney vary so much in severity, and in the violence of their symptoms, from a slight renal pain, with diminished and neutral urine, to a condition of profound prostration and sopor, with frequent rigors, simulating typhoid ague, that, as Rayer says, it is difficult to furnish a programme of their history; but in all the cases of this disease, when uncomplicated, you will meet with renal pain and tenderness, preceded by rigor, and accompanied by a diminution in the urinary secretion, and this liquid is

invariably found diminished in acidity. The decomposition of urea into carbonate of ammonia in the act of secretion, which takes place, normally, in the herbivoræ, occurs as the necessary result of inflammation in the kidneys of man. The completeness with which this decomposition takes place appears to be in a direct relation with the amount of secreting surface inflamed, the urine in double nephritis being actually alcaline in its reaction. But we are to beware, in noting alcalinity of the urine as a sign of nephritic inflammation, lest this alcalinity may have been produced by food, medicine, or putrefaction in the bladder. Some kinds of fruit, such as cherries, prunes, and grapes, when eaten in great quantities, render the urine alcaline; salts of the vegetable acids with alcaline bases, such as Rochelle salts, acetate of potash, and even cream of tartar, are liable to produce the same effect; the caustic and carbonated alcalies will, as might be expected, have this result; as will likewise the iodide and sulphuret of potassium. If the urine be retained for a considerable time in the bladder, it is apt to ferment; and this process will be facilitated by the presence of pus and blood. You perceive, therefore, that there are many causes besides renal inflammation which may render the urine neutral or alcaline; but you are aware that the buffy coat on the crassamentum may also be produced by a variety of causes, and yet no one will deny its value in diagnosis; and, in a similar manner, the nature of the urinary reaction with test papers, constitutes a most important element in the diagnosis of nephritis. The exhibition of mercury sometimes renders the urine alcaline; but this is the effect of an action of this metal on the kidneys, analogous to that which it produces on the salivary and other glands.

The diminution in the quantity of the urine may pro-

ceed to complete suppression. In that case, cerebral symptoms will, sooner or later, arise.

Nephritic Complication in Typhus Fever.—Just as the brain, the lungs, the heart, or the intestines, may become the seats of complications in the progress of Typhus Fever, so may the kidneys. I have already described the pathological appearances of this complication ; let us now examine the method of its diagnosis. Like the majority of the complications of typhus, this lesion is extremely latent. In the stage of reaction, there may be violent pain in the back, just as in other instances you observe patients suffering from severe cephalalgia ; but this symptom affords you no clue to the renal affection. It is in the stage of prostration that this complication is most liable to arise ; seldom is it accompanied by pain ; the patient is without any expression of pleasure or suffering upon his countenance ; the ordinary putrid symptoms are generally well marked ; the urine is scanty and high-coloured, but upon cooling it deposits no sediment ; at length it ceases to be secreted ; constant stupor overpowers the cerebral functions ; he dies, and the attending physician probably names the disease which has produced this catastrophe, simple fever, overlooking the important lesion which had arisen during its course.

A scanty, high-coloured, transparent urine is regarded as a bad sign in fever. So is dulness on percussion over the surface of a lung, a bad sign ; so is diarrhœa, with iliac gurgling a bad sign. But these signs are bad because they point to serious anatomical alterations ; and the lesion which the kind of urine I have referred to indicates is that of congested-softened kidney.

The scanty and concentrated urine remains transparent upon cooling, in this case, because it is neutral or alca-

line; the neutral urates remain dissolved in a quantity of water, from whence the superurates would deposit; and it is this essential neutrality or alcalinity of the urine, conjoined with its scantiness, which betrays the existence in typhus fever of a renal complication. If the urine be not only scanty and neutral, but likewise albuminous, the prognosis is still more grave, as this betokens that the ducts are also engaged.

Chronic Nephritis.—This is the disease which has been usually called the phosphatic diathesis; but in place of an increased secretion of phosphates, these salts are usually diminished in quantity in this affection. Phosphates in this disease are certainly deposited from the urine, but the reason why they are so is because the urine is neutral or alcaline.

Habitual pains in one or both lumbar regions, coinciding with diminished acidity or alcalinity of the urine, and a sentiment of feebleness in the inferior extremities; these are the principal characters of chronic nephritis.

The pains are not invariably present, and at other times are so slight, that the patient will not mention them until asked. Unless complicated, there is no fever, but the patients emaciate insensibly.

The urine is pale, troubled, of low specific gravity, although not passed in more than usual quantity, and feebly acid or neutral.

Extra Renal Abscess.—It is necessary to allude to phlegmonous inflammation of the cellular tissues surrounding one or both kidneys, as it is liable to be mistaken for nephritis. But in this case the urine continues acid, although it is generally scanty, and deposits lithates; the pain, also, soon assumes a pulsating character; deep-seated pressure detects a boggy feel in the renal regions,

and when matter becomes formed, fluctuation may frequently be detected.

Rheumatism of the Kidneys.—This is the only disease in which I have ever observed an excessive secretion of urates. You are to recollect that a specimen of urine permitting to subside on cooling, a bulky deposit of urates is no proof that the individual who passed it secreted an excess of these salts ; for their subsidence may have proceeded not so much from their superabundance as from a deficiency of the water necessary for their solution. This is what usually takes place in febrile diseases ; the quantity of urine becomes diminished, from a secondary irritation of the kidneys : and the solid constituents remaining unchanged, the sparingly soluble superurates have not enough of water for their solution in the cold. The urine consequently, throws down what is called a lateritious sediment. But in rheumatism of the kidneys an actually increased secretion of uric acid takes place ; and although when the disease becomes chronic, an absolutely superabundant quantity of urine may pass daily, it will deposit superurates copiously upon cooling. If a patient, subject to rheumatism in other parts, complains of burning heat in the loins, and passes abundant urine, which upon cooling deposits superurates, I would be led to diagnose rheumatism of the kidneys.

Gout of the Kidneys.—When gout attacks the kidneys, the urine undergoes the acetous fermentation which I mentioned in my first and second lectures. This new acid liberates the uric acid from combination, and this latter, consequently, subsides in its crystalline form. If the attack of gout be severe, the urine may also become bloody and albuminous ; but a permanent deposition of crystalline uric acid from the urine should be sufficient of itself to

make us diagnose gout of the kidneys. This deposition should, however, take place soon after emission, to justify this diagnosis ; otherwise, if the urine be saccharine, the lactic acid formed by fermentation may soon throw down crystals of uric acid. And I have known a similar deposit to have taken place from the vessel into which the urine had been received, accidentally containing some drops of nitric acid, which had not been washed out.

Bright's Disease.—An habitually dry skin, with a considerable quantity of albumen in the urine, are the most constant characters of this disease. When it becomes somewhat advanced, the solid constituents of the urine are diminished ; and if, in addition, anasarca be present, the diagnosis becomes as complete as anything can be in medical science.

The quantity of the urine is often apparently increased. I say apparently, because it is not really even as much as it ought to be, when we consider the nearly total suppression of the functions of the skin.

Acute Ureteritis.—In this disease there is pain along the course of the ureter, retraction of the corresponding testicle, and pain along the inside of the thigh. The urine is albuminous, and increased in specific gravity. It is acid, unless the disease be complicated with nephritis.

Passage of a Calculus along the Ureter ; or, Nephritic Colic ; is characterized by nearly the same symptoms, together with occasional vomiting ; but the urine is scarcely albuminous, and is frequently sanguineous. The differential diagnosis between this cholic and ureteritis, consists in the suddenness, severity, and evanescent nature of the attack. A discharge of small calculi may be expected in its suite.

Acute Cystitis.—If the urine be albuminous, without

he rational symptoms of acute ureteritis, or mottled idney, but with pain and tenderness immediately above he pubis, and pain excited by pressing the bladder from he rectum, you are justified in making the diagnosis of cute cystitis. There is generally considerable pain at the xtremity of the penis. Besides acute inflammation of the rinary passages and conduits, there are many other ources of albumen in the urine. I have already alluded o one of these, under the head of hæmaturia, p. 59 ; but his element is also frequently present in tubercular and ancerous diseases of the urinary apparatus, and is some-imes critical in acute inflammation of distant organs.

Chronic Ureteritis.—In this case there may or may not be deep-seated tenderness in the regions of the ureters ; here is seldom retraction of the testicle, or pain along the high. The urine is mixed with pus, which is in small quantity invariably present, and capable of being thoroughly suspended by agitation for some time after its first subsid-ence. These are the usual characters of chronic ureteritis ; but it occasionally happens that the disease is produced by the impaction of a calculus in the ureter. When this is the case, the pus is less constantly present ; it may be, in a great measure prevented from escaping—and, accumu-lating in the pelvis and infundibula, may distend the pas-sages, cause absorption of the tubular and cortical sub-stances, and reduce the kidney to the appearance of a large abscess. This disease, formerly called chronic neph-ritis, and abscess of the kidney, may be detected by the coincidence of a fluctuating tumour in the renal region with pus in the urine.

Chronic cystitis.—When this disease is present, there exists that which is called a catarrh of the bladder ; the urine becomes loaded with pus, which most usually presents

itself in the form of a glairy, tenacious sediment, incapable of being mixed by agitation with the urine.

For the diagnostic value of blood and sugar, I must refer you to pages 55 and 58.

LECTURE VI.

ON THE TREATMENT OF URINARY DISEASES.

It has long appeared to me a grievous error in the treatment of urinary diseases, the habit of regarding the alterations of the renal secretion in a purely chemical light. Exhibiting acids, if the urine be alcaline, and alcalies if this liquid be acid ; and modifying the food, so as to diminish the chances of sugar getting into the system in cases of diabetes mellitus ; these simple and most erroneous principles satisfy and guide the majority of practitioners in their treatment of urinary diseases. This error is not peculiar to the therapeutics of renal lesions ; we every day see alcalies exhibited in pyrosis, not with the idea of curing the lesion of innervation, which constitutes the disease, but with the hope of neutralizing the acid secretion which is the effect. Yet, how much opposed to rational pathology is the theory upon which treatment of this kind is founded ! and how ineffectual is it, usually, in the relief of those diseases to which it has been applied ! You will see patients suffering from gastralgia and pyrosis, taking alcalies in large quantities for weeks and months, without obtaining any permanent benefit ; you will see patients emaciated and debilitated from chronic nephritis, or, as it has been most erroneously called, the phosphatic diathesis, taking the mineral acids, for a very long period,

without the urine becoming a bit less alcaline. Others, having gout or rheumatism of the kidneys, will have consumed pounds of the bicarbonates of potash and soda; during their use, lithates or crystallized lithic acid will cease to deposit; but as soon as the employment of these salts is intermitted, the uric acid, unaltered in quantity, and merely kept dissolved by the alcalie, will, upon the disuse of the latter, precipitate in as large quantity as ever. Theory and experience equally demonstrate the inutility of the chemical treatment of urinary diseases.

Why not treat urinary diseases on the ordinary principles of therapeutics? There are really no lesions discoverable in the various parts of the urinary apparatus, but such as you meet with in other portions of the organism. Plastic and suppurative inflammations, gout, rheumatism; alterations of nutrition, secretion, and innervation; these are all common to the different viscera of the cranium, the thorax, and the abdomen. It appears reasonable to expect that the means experienced to be generally serviceable in a diseased condition of one organ, will be found equally beneficial in a similar disorder of another organ; and although it is certainly true that the utility of the same medicine will be found to vary according to the organ affected with a given lesion; and calomel in iritis, tartar emetic in pneumonia, turpentine in sciatica, colchicum in gout, iodide of potassium in periostitis, and opium in peritonitis, are examples of medicines which manifest an antagonism to inflammations in certain organs, much superior to what they display in other instances; still they present resemblances in their physiological and therapeutical effects sufficient to entitle them to be regarded as a distinct class of medicines; and in many cases they may be advantageously substituted for each other. Not the less, therefore,

is the knowledge of the lesions of the urinary organs, and of accurate diagnosis, a guide to the groups of therapeutical means amongst which you will have to select; although the determination of the particular remedies, especially serviceable in any given lesion located in some portion of the urinary apparatus, may be the specific province of experiment.

A strict adherence to system would therefore lead me to describe the treatment of urinary diseases, in the suite of their pathology and diagnosis; and if I pursue on the present occasion a different system, it is not because the pathology and diagnosis of these diseases are insufficiently developed for the purpose; for I consider that although we have much to learn with respect to the diseases of every viscus, the knowledge of urinary disorders has so rapidly progressed within the last few years, as to have now arrived, at least, to a level with other departments of medical science; but, unfortunately, this knowledge is but very little diffused among the members of the medical profession; philosophical views of the nature of disease are seldom entertained; the majority of practitioners still continue to wander through the misty regions of diathesis; and in place of looking through symptoms into lesions, are contented to rest on the superficial and sensible consequences of diseased action.

To render this lecture as generally useful as possible, I shall therefore tell you the treatment proper to each urinary indication, instead of that required by the governing lesion. And in this way I hope to be enabled to bring together into one view, the pathology, diagnosis, and appropriate treatment, in such a manner as that each of these subjects may throw light upon the others.

Treatment of Diabetes Insipidus.—This is the name

given to a symptom of urinary disease, in which an excessively increased quantity of water is habitually secreted from the kidneys, without any alteration of the solid elements of the urine. The specific gravity of this liquid becomes, consequently, very much reduced. This symptom appears to depend on altered innervation, and it is best treated by the internal use of antispasmodics and mineral tonics, with the external employment of stimulating liniments to the spine.

Treatment of Lithic Acid Deposits.—These deposits are either crystalline or amorphous. When the urine for any length of time continues to deposit, after each emission, the rhombic prisms of lithic or uric acid, this circumstance is an evidence that the kidney is affected with gout : under such circumstances, the immediate danger is the formation of a calculus ; and, to obviate this, it is desirable to exhibit either bicarbonate of soda or potash, in doses of ten grains or a scruple, dissolved in half a pint of water, three times a-day, so as to render the urine neutral or alcaline : but this effect being obtained, the practitioner ought to direct his efforts to subdue the gout, which is the cause of the symptom. If the urine be albuminous or sanguinolent, and there is much pain in the loins, it shews the attack to be of an inflammatory character, and to require a treatment locally antiphlogistic ; otherwise recourse may be had to colchicum, or whatever remedy the practitioner prefers in the treatment of podagra.

If the lithic acid deposit be amorphous, its precipitation may depend either upon an excessive secretion of the solid constituents of the urine, or upon a deficiency in the secretion of water. In the former case, the specific gravity of the urine becomes normally increased, in proportion to its quantity : and this symptom is usually dependent on

rheumatism of the kidney. The treatment should, of course be directed to the rheumatism, at the same time it is desirable to hold the excessive lithates in solution by means of alcalies. Iodide of potassium is a medicine that fulfils both indications, and, given in doses of five or ten grains three times a-day, will usually be found serviceable.

When the amorphous lithates become deposited from a deficiency of water, the quantity of urine will be ascertained upon inquiry to be less than usual. Sometimes, however, the patient is deceived as to this point by the concentrated and stimulating secretion, demanding frequent evacuation ; under all circumstances, it is most desirable, for diagnosis, that the daily discharge of urine should be measured. Diminution of the watery part of the urine may be produced by irritation of the kidneys either idiopathic or symptomatic ; or it may be the result of a lesion of innervation ; or it may be the consequence of a vicarious watery secretion from some other organ. When the deposited lithates are of a brick red colour, the scanty secretion of water which produces their subsidence is the effect of the first of these causes ; in that case, a fever, either essential or symptomatic, exists ; and the remedies calculated to remove the fever are those fitted to increase the urinary secretion and diminish the lithic deposit. If the deposited lithates be pale or buff-coloured, the chances are that they are caused by a nervous diminution of the watery element, connected with that weakened action of the ganglionic nervous system to which the name of dyspepsia is given ; if such be the case, the internal exhibition of a scruple of alum in half a pint of water, three times a-day, will soon remove the tendency to lithic acid deposit. A pink colour of the sediment is usually found in connection with an imperfect discharge of the biliary functions.

Treatment of Phosphatic Deposits.—These deposits, when principally crystalline, generally depend upon the urine being deficient in acidity ; in that case, the treatment will be described under the head of alcaline urine. Sometimes, when the bladder has been long diseased, a copious deposit of amorphous phosphates subsides from the urine ; it is always under such circumstances accompanied with pus ; and the indications which are thus afforded for treatment I shall hereafter mention.

Treatment indicated by Weakly Acid, Neutral, or Alcaline Urine.—In my last lecture I pointed out the circumstances under which the urine becomes diminished in acidity, whether in health or in disease. If the urine be neutral, or weakly acid, from a vice of secretion, it usually shews that the kidneys are inflamed. I have already described to you the differential diagnosis of acute nephritis, chronic nephritis, and the renal complication of typhus fever. In acute nephritis, the employment of general and local depletion, as well as the exhibition of emollients and contra-stimulants, must be regulated by the severity of the disease and the state of the constitution, according to the ordinary principles by which inflammations are combatted : I am persuaded that I have seen much benefit from large (ϑ)doses of hydriodate of potash in this disease. In chronic nephritis, you will find great benefit from local depletion and counter-irritation, especially from the establishment of setons in the neighbourhood of the affected glands. In the renal complication of typhus, blisters to the loins, and the internal administration of wine, are usually indicated ; small doses of oil of turpentine will, in these cases, often increase the quantity and restore the acidity of the urine.

Treatment of the Oxalate of Lime Deposits.—Although

there can be little doubt that oxalic acid is generated in the urine by the putrefactive decomposition, and often occurs subsequent to secretion, in a manner totally independent of disease, (see Lecture II.), yet it is also certain that this decomposition frequently results from an essential vice of secretion. The morbid conditions which give rise to this change are not yet known ; but one thing is well ascertained, that in every instance of the kind there is frequent desire to pass water, pain in passing it, and that the secretion is commonly loaded with epithelium. These phenomena proclaim the existence of irritation of the mucous membrane. Sometimes the crystals of oxalate of lime, like those of uric acid, cohere in the calyces and infundibula, forming calculi, which produce paroxysms of nephritic colic, by their descent into the bladder. In such cases, inflammation of the lining membrane may be mechanically produced ; but it is doubtful whether the symptoms of mucous irritation which usually accompany the oxalate of lime deposit are due to the irritating contact of the sharp crystals. Whatever is the cause of the mucous irritation, it constitutes the lesion which in oxalate of lime diathesis you are especially called on to remove ; and its successful treatment requires no little delicacy in the application of therapeutical agents. Unlike acute mucous inflammation, depletion and emollients will act in this irritation injuriously, if employed in the first instance ; you must have recourse to tonics immediately, such as the mineral acids, vegetable bitter astringents, &c. ; and having employed these means for some time, you will then find the greatest benefit from alcalies largely diluted. It will be often necessary to alternate these methods of treatment for a considerable period, but you will generally find that ultimate benefit will be derived from steady persistence in their

ise. The form of tonic mixture which I usually employ in hese cases is the following :—

℞.	Infusi Cascarillæ	℥ 6
	Nitratis Potassæ	ʒ j
	Acidi Nitrici diluti	ʒ l ½
	Tincturæ opii	ʒ j

M. sumat cochlearia duo ampla ter in die.

Treatment indicated by Albuminous Urine.—In my last lecture I have sufficiently pointed out the method of distinguishing mottled kidney from acute mucous inflammation—the two principal pathological causes of albuminous urine. In my fourth lecture I gave you reasons for regarding the disease which terminates in mottled kidney, as essentially an inflammation of the lining of the urinary conduits. I must refer you to the same lecture for a list of the other diseases in the course of which the urine becomes albuminous ; but, for the present, we shall confine our attention to the treatment of the two diseases alluded to. These diseases, according to the views which I have laid before you, are both acute inflammations, standing in the same relation to each other as croup, bronchitis of the large tubes, and capillary bronchitis. Their treatment must consequently be very similar ; active depletion both local and general, the continued exhibition of nauseating doses of tartar emetic ; hydrogogue purgatives ; warm baths ; and all the resources usually had recourse to in active inflammations of internal viscera. Modern therapeutics has made no more valuable discovery than that of the utility of alcalies in cases of mucous inflammation. The diseases under consideration are particularly suited for continued alcaline medication, subsequent to the employment of more energetic agents. These means will require to be strenuously persisted in ; but it is a common character of urinary

inflammations much to diminish the strength, and to deteriorate the constitution; this is particularly true of Bright's disease; and when this cachectic condition is produced, you will be forced to intermit your active antagonism to the local disease, for the purpose of obviating the still more imminent dangers resulting from an impoverished blood and an exhausted fibre. Under such circumstances you must depend on an active counter-irritation, especially by setons, to controul the urinary inflammation; and Dr. O'Ferrall has in these cases found much advantage from the internal exhibition of acetate of lead, (vide Dublin Hospital Gazette, No. 22.)

Treatment of Diabetes Mellitus.—If you agree with me in the pathology of this disease, developed in my fourth lecture, you will easily be enabled to deduce what treatment is most appropriate. I look on saccharine urine as depending on a modification of the epithelial secretion produced by an asthenic condition of the urinary conduits. If this be the case, medicines calculated to exalt the tone of the secreting capillaries are those best fitted to restore the natural function. Accordingly, experience tells us, that the balsams, ammonia, strychnia, and other excitants, are the medicines found most beneficial, when the perspiratory secretion is suppressed; when, on the contrary, the functions of the skin continue unimpaired, much benefit is often derived from the internal use of chalybeates, alum, sulphate of zinc, or other metallic astringents. The whole system commonly shares either directly or consecutively in the debilitated condition which exists in the capillaries of the conduits, and it is therefore most desirable to employ every dietetic means calculated to increase the patient's strength. It is well, therefore, to give a moderate proportion of animal food, porter, &c.. as much as is consistent

with a proper exercise of the digestive functions ; but from the exclusive animal regimen recommended by some, I have seen decidedly injurious results, but never any lasting benefit.

Treatment indicated by Purulent Deposits.—In my lecture on the pathology of urinary diseases, have been described the different sources of pus in the urine ; and in my lecture on the diagnosis of urinary diseases, I have mentioned the methods of distinguishing these pathological causes from each other. We have seen that the urinary mucous membranes pour out pus when in a state of asthenic inflammation : and this circumstance sufficiently indicates the appropriate treatment. Tonics are the medicines chiefly to be relied on in these cases ; decoction of the leaves of Chimaphila corymbosa, Diosma crenata, or Arctystaphylos uva ursi ; or of the root of Cissampelos pareira ; combined with mineral acids, will usually be found serviceable ; chalybeates are also often of efficacy in these cases.

Treatment of Hæmaturia.—In my fourth lecture are enumerated the different sources which give origin to bloody urine. It is not our province to speak of wounds or contusions of the urinary organs, nor of general diseases such as scurvy or purpura ; we shall therefore confine our attention to vicarious and essential hæmaturias. I have told you that the seat of vicarious hæmorrhage occurring in the urinary organs, is usually the lining membrane of the bladder. These cases you treat in the usual manner that other vicarious hæmorrhages are combatted. The most efficacious treatment of essential hæmaturias consists in the exhibition of astringents, such as tannin, or styptics, such as oil of turpentine ; the use of the latter is very apt, however, to convert the hæmaturia into a ne-

phritis, but in this case the reaction of the urine with litmus paper affords a most accurate test for pointing out the critical time when you should stop the exhibition of the medicine and cup the loins.

I have now given you the principal indications for treatment, afforded by modifications of the urinary secretion; and at this point the present course of lectures must close. It has been my object to steer as clear as possible from the published works on the subject of urinary diseases; at the same time that I wished to furnish you with principles which might guide you to a philosophical pathology, a safe diagnosis, and a scientific and successful treatment.

THE END.

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