floor is occupied by the steam-engine, the heat from which, together with the foul air of the intermediate rooms, rises into the upper floor. In most cases of this kind the two upper floors are thickly occupied by compositors. Now two printing offices having this very faulty construction supplied me with two comparisons, which I was not surprised to find issued in a decided confirmation of the results to which I have just referred. In one of these offices, 15 men were employed on the second floor, and 17 men on the third and uppermost floor. Of the 15 men on the second floor, 1 had a cough, 1 was subject to indigestion, 1 had ulcers of the legs, and 1 might be termed a valetudinarian. But of the 17 men employed in the upper room, with a smaller quantity of a more impure air to breathe, 3 had spit blood, 2 were subject to affections of the lungs, and 5 to constant and severe colds. In the other printing office, out of 15 men employed in the lower of the two rooms, 1 only had spit blood, 1 complained of weakness, and 1 of dyspepsia, making 3 in all; while out of 20 men in the upper room, having less and worse air to breathe, 2 had spit blood, 2 were dyspeptics, 2 had rheumatism, 2 were hypochondriacs, 1 was subject to headache, and 1 had varicose veins. In the lower room, the invalids were as 4 in 20; in the upper room, as 10 in 20.

The general results of the inquiry were in strict accordance with those drawn from the smaller numbers of facts; and though the whole body of facts scarcely exceeds 300, I place as firm a confidence in the broad general principle which the figures express as I do in the most rigorous and exact demonstration of the mathematics. Had the percentage proportions differed but little from each other, I should have spoken with hesitation, and waited either for more facts of the same order, or for confirmation, or the reverse, at the hands of others.

To this illustration of the sufficiency of comparatively small collections of facts, I will add a second, drawn from my inquiries into the health of a class of men whose hard case is now deservedly attracting much public attention and sympathy. I may state briefly that these men (the journeyman bakers) are exposed to the combined operation of overwork and nightwork, of a very confined, heated, and impure atmosphere, and of frequent mechanical and chemical irritation of the lungs—the mechanical irritation of the flour, and the chemical irritation of the sulphurous acid and smoky gusts from the oven's mouth. Well, I compared these men with other classes, and particularly with the compositors. I purposely selected about 100 compositors working in the smallest, closest, and hottest rooms, and, taking the occurrence of hæmoptysis among them as a good test and measure of their liability to consumption, found it at the rate of 12½ per cent. This proportion, be it recollected, represents the extreme of disease among compositors. This result I proceeded to compare with the percentage of spitting of blood in 111 journeymen bakers. It turned out to be 31 per cent. But when I compared this worst group of compositors with the poor bakers who work in the worst places for the worst class of masters—I mean the under-priced bakers—the proportion rose to 1 in 2; and of those whom I examined, no less than 6 in succession had spit blood. Now, here again, if I had not sought and found additional facts of the same class, I should have certainly placed the most perfect reliance on the results of this comparison of one century of facts with another. I should have felt confident that my percentages were the numerical expression of a great truth, though not of the precise ratio of the liability to consumption of the two classes of men.

I will ask your attention to only one more inquiry of this kind. Having, several years since, obtained from the Registrar-General nearly 10,000 ages at death of adult male inhabitants of London dying in 1839, I arranged them in groups, with a view of illustrating the influence of occupation and habits of life upon health. One habit, the influence of which upon health it seemed desirable to ascertain, was that of intemperance; and I thought that if I compared the average age at death of certain classes known to be peculiarly exposed to the temptation of drinking with the classes most resembling them, but not so exposed to temptation, I should obtain some instructive results. I accordingly compared the brewers' draymen with the mass of labourers, potboys with footmen, and licensed victuallers with other tradesmen. In each case I found the percentage proportion of deaths between the ages of 30 and 50, and particularly between the ages of 30 and 40, in excess in the class of men most exposed to the temptation. In the case of two out of the three comparisons, the excess was such as to show itself most strikingly when the percentages were converted into curves. Now, this was a case of what would be generally thought a very insufficient collection of facts. The deaths of draymen were only 51 in number; and those of potboys or pot-

men only 61. The other classes were much more considerable, and perhaps adequate in number. Now, I should have attached no importance to those figures, or to the curves which represent them, if the percentages and curves had approximated at all closely to each other. But as it was, I deemed the figures and curves good, partly for illustration, and partly for use in conjunction with other facts leading to the same results.

And here let me observe, that as a broad general rule (at least in my own experience), the numerical results obtained by dealing even with moderate collections of facts have very generally borne out the views of the sounder class of thinkers, who have formed their opinions by means of that unrecorded collection of observations which we call experience. Perhaps I ought to add that they have as often run counter to the hypotheses and theories of men who have shaped their views upon their wishes and hopes, rather than upon their real experience.

In my next and last lecture, I shall consider the most interesting general fact which statistical inquiries have made known to us—the recurrence, year by year, of aggregate figures of nearly equal value, as representatives of the great leading facts of social and medical science.

A Course of Lectures ON URINE, URINARY DEPOSITS, AND CALCULI.

DELIVERED AT THE PATHOLOGICAL LABORATORY,
DURING THE SESSION 1857-58.

BY

LIONEL BEALE, M.B., F.R.C.P., F.R.S.,

PHYSICIAN TO KING'S COLLEGE HOSPITAL; PROFESSOR OF PHYSIOLOGY
AND OF GENERAL AND MORBID ANATOMY IN KING'S
COLLEGE, LONDON; ETC.

LECTURE VI.

THE ANATOMY OF THE KIDNEY. ITS ACTION IN HEALTH AND DISEASE. *Cortical and Medullary Portions of the Kidney. Pelvis. Mammilla. Infundibula and Calyces. Artery. Vein. Nerves. Lymphatics. Secreting Apparatus. The Uriniferous Tube. Of the Circulation in the Kidney. Epithelium. Of the Basement Membrane of the Tubes and of the so-called Matrix. On some Points connected with the Physiology of the Kidney. ON THE FORMATION OF CASTS OF THE URINIFEROUS TUBES. Of the Cast. Circumstances under which the Renal Secretion may be altered in Quantity or Quality. On the Absorption of Substances from the Stomach, and their Excretion in the Urine. MORBID CHANGES AFFECTING THE STRUCTURE OF THE KIDNEY. Of Bright's Disease. Dr. Johnson's Investigations.*

[Continued from page 490.]

On some Points connected with the Physiology of the Kidney. The course of the blood has been fully described, and it has been shown how eminently adapted the Malpighian tuft is to facilitate the free escape of the watery parts of the blood. The influence of the nervous system upon the secretion of urine is well known. Nerves may be traced upon the large arteries, and followed on the small vessels for a considerable distance. I have seen nerves upon the Malpighian arteries which may be traced up to the tuft. I have not succeeded in demonstrating nerves in connexion with the capillaries of the tuft; but a careful examination of several specimens has led me to conclude that these capillaries are supplied with nerves, as appears also to be the case with the capillaries of the ciliary processes of the eye, and some other capillary vessels. I am now investigating the mode of distribution of the nerves to vascular structures, and I hope soon to be able to express myself more definitely on these very interesting questions.

Virchow lays considerable stress on the existence of a collateral circulation through the vasa recta. He considers that the circulation in the medullary portion of the kidney is more free than it is in the cortex, because the blood in the latter region does not pass through Malpighian bodies. There can be no doubt of the correctness of Virchow's views upon this question, and I can confirm many of his statements from personal observation. Some time since, in examining some specimens of diseased kidney, I was much struck with the thickness of the walls of some of the vasa recta in the pyramids. Upon

further examination, these were found to exhibit the circular muscular fibres so characteristic of arterial walls. I have since carried out further investigations upon the healthy kidney, and

Fig. 21.—Capillary vessels from the Malpighian tuft of a human kidney which had been injected with dilute Prussian blue injection, showing nuclei connected with their walls. *a.* A few coils separated from the rest of the tuft. *b.* Part of a loop somewhat compressed, showing the nuclei a little flattened. *c.* Tissue which connects the coils with each other, and thus the globular form of the tuft is preserved, even when it is removed. *d.* A small portion of a capillary compressed as much as possible, showing the thickness of the capillary wall at the point of reduplication.

have found that many of the straight vessels running parallel with the tubes in the pyramids of the kidney are in reality small arterial branches with muscular walls. These are supplied with nerve-fibres. I suspect that some of these branches communicate very readily with the veins in the same situation. This subject is one of very great interest, in connexion with the renal circulation.

In a state of health, the diminished rapidity of the circulation in the capillaries of the Malpighian body, consequent upon the greatly increased area of the capillaries which the blood must traverse as it flows from the small artery which alone supplies them, favours the transudation of water through the capillary walls. This fluid must at once pass into the uriniferous tube; and as it gradually traverses in succession the cells which line it, the soluble substances which they are at the same time separating are dissolved out—the quantity of solid constituents gradually increasing as the solution passes down the tube. Now, the blood just brought from the Malpighian body has parted with water, and is richer in urinary constituents than the blood in any other part of the kidney. This is conducted by the vessels into which the efferent vessel of the Malpighian body divides to the upper part of a uriniferous tube near the Malpighian body. We should expect that the cells in this region would be more fully charged with soluble urinary constituents than those lower down the tube; and, in accordance with this view, we find that these cells are acted upon by the almost pure water which has just escaped from the capillaries of the Malpighian bodies; while, by the time the fluid has reached the cells at a lower point of the tube, it is already charged to a great extent with soluble constituents, and its solvent power is, of course, proportionately diminished.

Not the least important office of the cells lining the convoluted portion of the uriniferous tube is undoubtedly that of separating from the blood a considerable quantity of the *débris* of blood-corpuscles, in the form of extractive matters. It is possible that the cells may have the power of altering some of the substances they separate from the blood, and converting them into these peculiar urine extractives, the physiological importance of which, we may feel sure, must be very great, from the large amount which is excreted.

I have ventured to ask your attention to these minute anatomical points, because they seem to indicate conclusively the office performed respectively by the Malpighian body and by the epithelium of the uriniferous tube, as discovered by Bowman nearly twenty years ago. These views have lately been opposed by Dr. Isaacs in America, who tries to prove that the solid constituents are separated by an epithelium covering the capillaries of the Malpighian body (which, if it exists, is certainly very unlike glandular epithelium generally, and the cells must be very much smaller than he has represented); while, strange to say, he does not attempt to show what office is performed by that enormous extent of epithelial surface in the

convoluted portion of the tube, or why the very peculiar relation between the extensive system of capillaries around the tubes and those of the Malpighian body exists. Bowman's views on the physiology of the kidney are supported by so many different facts, that they are now received by all who have carefully studied the subject from the different points of view which he has indicated.

On the Formation of Casts of the Uriniferous Tubes. Such, then, being the action of the kidney in health, let us consider briefly how this may become altered in certain cases. If the arterial walls were relaxed, more blood would pass into the Malpighian capillaries in a given time, and a great transudation of water would take place. If, on the other hand, the capillaries were contracted, the secretion of urine would be diminished accordingly. Many sudden and temporary alterations in the circulation of the blood through the Malpighian bodies of the kidney undoubtedly depend upon an influence exerted by the nervous system alone; but certain changes which are, unfortunately, of a more permanent character, are due to an altered action of the secreting cells. The rapidity of the circulation in the Malpighian body will be greatly influenced by the rate at which the blood traverses the capillaries around the uriniferous tubes; the flow of blood in these vessels being governed by the attractive force exerted by the cells within the tubes for the urinary constituents dissolved in the concentrated blood. Now if, from any cause, the action of the secreting cells became impaired, and they ceased for a time to exert their attraction for the constituents they ought to separate from the venous blood, a retardation to the circulation in these capillaries would result. This would affect backwards, as it were, the capillaries of the Malpighian tuft, in which the blood, urged on through the arteries, would tend to accumulate. Their thin walls, being much stretched, would not resist the passage of other constituents of the blood; albumen and extractive matters would pass into the tube, and escape in the urine. Supposing this state of things to go on, the pressure on the Malpighian capillaries must necessarily increase; and these capillaries, distended to their utmost, and their walls stretched to the last degree, would at length burst, and all the constituents of the blood, including the blood-corpuscles, would pass into the tube, and would escape with the urine. The density of the walls of the Malpighian capillaries, which permits the escape of water in health, will favour the escape of other constituents of the blood, and increase their chance of rupture in disease, if they be exposed to increased pressure; but the collateral circulation above referred to in some measure counteracts such a result.

Professor Virchow has lately arrived at the conclusion that albumen and other constituents of the blood more frequently escape from the straight vessels of the pyramids than from those of the Malpighian bodies. In the former case, the constituents of the blood would have to pass through the walls of the tubes, as well as through those of the capillaries; while surely, if this were the seat of the mischief, we ought to find an oedematous condition of the kidney, and blood effused between the tubes more frequently than is the case. It seems to me that, before such a lesion was possible, the Malpighian capillaries must have become much thickened and altered in structure. In many chronic cases, as has been shown by Dr. Johnson, the Malpighian arteries become enormously thickened; and I have often observed the capillaries of the Malpighian body in a like condition; so that the permeability of their walls must be very greatly diminished.

In many cases of congestion, and in inflammation of the kidney, a spontaneously coagulable material is effused into the tubes, and coagulates there, forming a *cast or mould of the tube*, which is gradually washed out by the fluid which is secreted behind it, and thus it finds its way into the urine, from which it may be easily separated for examination.

Casts. A cast is composed of a coagulable material which is effused into the uriniferous tube; and, becoming solid there, it entangles in its meshes any structures which may be in the tube at the time, and forms a mould of the uriniferous tube. The characters vary very much in different cases, according to the state of the tubes and the part in which the effusion of the matter takes place. Various substances are often entangled in the cast; and, by observing the character of these, we are often enabled to ascertain the nature of morbid changes going on in tubes at the time the cast was being formed. Great difference of opinion has been expressed with reference to the nature of the material of which the cast is composed. By some it has been termed fibrine; but the striated appearance always present in coagula of this substance is not found in the cast. Others

have considered the cast was composed of albumen; but it is not rendered opaque by means of those reagents which produce precipitates in albuminous solutions. Not more than five years since, it was stated by two observers in France and Germany of high reputation, at least in other branches of scientific inquiry, that the cast really consisted of the basement membrane of the uriniferous tube. How such a statement could be made by any one possessing even a slight knowledge of the anatomy of tissues, it is difficult to conceive.

The transparent material probably consists of a peculiar modification of an albuminous matter possessing somewhat the same characters as the walls of some epithelial cells, the elastic laminae of the cornea, the walls of hydatid cysts, etc. I think it not improbable that these casts of the uriniferous tubes may really be composed of the material which, in health, becomes converted into epithelial cells. In disease, this substance, perhaps somewhat altered, passes into the uriniferous tubes, and coagulates there. If this be so, the formation of the cast must result from depraved nutrition, and the material must pass into the tube from the intertubular capillaries—an idea which receives some support from the fact that occasionally casts are formed although no albumen passes into the urine. According to this notion, it is possible that a cast might be formed quite independently of any congestion or morbid condition of the Malpighian tuft; but, as a general rule, there can be no doubt that serum escapes as well as the coagulable matter, and albumen is found in the urine.

The diameter and general character of the cast will be determined by the state of the uriniferous tube at the time of its formation, as the researches of Dr. Johnson have indisputably proved. If the epithelium be abnormally adherent, the cast will be very narrow; if, on the other hand, the epithelium be removed, it will be of the width of the tube. Should the epithelium be disintegrating, the cast will afford evidence of the change. If in a state of fatty degeneration, fat-cells will be entangled in it. In hæmorrhage from any part of the secreting structure, blood-corpuscles are present; and, when suppuration occurs, the cast contains pus-corpuscles. When the transudation of the coagulable material occurs in a tube to which the epithelium is intimately adherent, or in a tube whose walls are smooth, the cast will be clear and perfectly transparent. The import of all these different characters is fully discussed in the works of Dr. Johnson; and several interesting cases, under observation for a considerable period of time, will be found reported in Dr. Basham's work.

When discussing the different urinary deposits, we shall have to consider those forms of casts which are most frequently met with.

Professor Virchow thinks that casts are very constantly, if not certainly, formed in the straight portion of the uriniferous tubes; but you will, I think, feel satisfied that many of the facts we have been considering strongly militate against this idea. In morbid specimens, it is very common to see the casts in the tubes of the cortex. Moreover, as I have demonstrated in several cases, the cast receives successive layers upon its outer surface, as it passes down the tube (*Illustrations*, Plates xiv and xvi). In Fig. 22, portions of casts from the convoluted portion of the tubes are seen imbedded in transparent material, which has undoubtedly coagulated in the straight part of the tube. We may, therefore, conclude that much may be learned with regard to the nature of the morbid changes going on in

Fig. 22.—Casts of the uriniferous tubes from a case of acute suppurative nephritis. Casts found in the convoluted part of the tube are seen imbedded in material which has coagulated in the straight portion. Magnified 50 diameters.

the secreting part of the uriniferous tube by a careful examination of the characters of the cast, as there can be no doubt that casts are generally formed in the convoluted portion of the tube, although, in certain cases, the coagulable matter may be effused in the straight portion also, in which case the diameter of the cast will be very much greater.

[To be continued.]

Illustrations

OF

HOSPITAL PRACTICE:

METROPOLITAN AND PROVINCIAL.

LIVERPOOL NORTHERN HOSPITAL.

CASES OF ACUTE DISEASE OF THE CHEST.

Under the care of A. T. H. WATERS, M.R.C.P., Physician to the Hospital.

[From Notes by MR. JACKSON, Clinical Clerk.]

[Continued from page 455.]

CASE VI. *Pneumonia of the Left Lung: Recovery.* John Wain, aged 26, a strong stout healthy labourer, was admitted into the Hospital on June 8th, 1860. He had been quite well up to June 5th, and had been at work on that day. In the afternoon, he was attacked with "stitch" in the side and rigors, so as to be obliged to give up his work; during the night he had frequent vomiting, with pain in the side, dyspnea, and feverishness. He had kept his bed from the time of the attack, but had had no sleep. No treatment had been adopted.

When admitted, he complained of dyspnea, pain in the epigastrium and left side, increased on inspiration; the face was flushed, skin hot, tongue furred. The pulse was strong and full, 92. Respirations 36. There was deficient movement on the left side of the chest, with dullness, bronchial breathing, and crepitation over the lower half of the left lung behind, and extending forwards into the axilla. The breath-sounds and percussion were good over the right lung, and the anterior and upper part of the left. He was ordered to take a fourth part of the following mixture every four hours:—

R. Antimon. potassio-tartratis gr. iij; liquoris ammoniæ acetatis 3ij; aquæ ad 3vj.

Three grains of calomel and one of opium were given at bedtime. Low diet and beef tea were ordered.

June 9th. He had slept; there was less pain and dyspnea. He had expectorated small quantities of rust-coloured sputum. The skin was moist; the pulse had fallen below 70; the respirations were 24. The auscultatory signs were about the same, except that the crepitation was more distinct.

June 11th. The pulse was 60. The dullness was less, and the extent of crepitation had diminished. He was almost entirely free from pain. The mixture was omitted, and a small blister applied to the affected side. Chop diet was ordered.

June 14th. Crepitation could only be heard at the end of a deep inspiration at the extreme base of the lung. Respirations 20.

June 19th. The breath-sounds were normal all over the lung. He expressed himself as quite well, and was discharged.

CASE VII. *Pleuropneumonia of the Left Side: Recovery.* Charles Holmes, aged 32, a fireman on board ship, of fair muscular development and moderately stout, was admitted into Hospital on June 4th, 1860. He had been quite well, and had done his work up to the morning of June 1st. On that day, he had rigors, which were followed on the succeeding day by sharp pain in the left side, and cough. There had been no expectoration; he had undergone no treatment.

When admitted, he complained of acute pain in the left side, increased on inspiration; he could not lie on the affected side. There was deficient movement of the left side of the chest. The respiration was hurried. Pulse 88. There was dullness over the back of the left lung, extending up to the spine of the scapula, with absence of respiratory sounds at the extreme base, and distinct bronchial breathing and bronchophony higher up. The percussion and breath-sounds over the right lung and anterior part of left were normal.

He was ordered three grains of calomel and a grain and a half of opium at bedtime, with liquor ammoniæ acetatis mixture and five grains of nitre every four hours; and strong beef-tea for diet.

June 5th. The general symptoms and physical signs were about the same, but the pain in the side was more severe. Eight leeches were ordered to the seat of pain, and an eighth of a grain of antimony was added to each dose of the mixture.

June 6th. The pulse was 76; the pain less; he had been much relieved by the leeches. The dullness was less marked