

portant than the irritative effects of either the specific agents of the disease or the products produced in their growth, or in the altered metabolism of the tissues. The urine is diminished in amount, and may contain albumen and tube-casts.

(2) *Passive Congestion; Mechanical Hyperæmia.*—This is found in cases of chronic disease of the heart or lung, with impeded circulation, and as a result of pressure upon the renal veins by tumors, the pregnant uterus, or ascitic fluid. In the cardiac kidney, as it is called, the cyanotic induration associated with chronic heart-disease, the organs are enlarged and firm, the capsule strips off, as a rule, readily, the cortex is of a deep red color, and the pyramids of a purple red. The section is coarse-looking, the substance is very firm, and resists cutting and tearing. The interstitial tissue is increased, and there is a small celled infiltration between the tubules. Here and there the Malpighian tufts have become sclerosed. The blood-vessels are usually thickened, and there may be more or less granular, fatty, or hyaline changes in the epithelium of the tubules. The condition is indeed a diffuse nephritis. The urine is usually reduced, is of high specific gravity, and contains more or less albumen. Hyaline tube-casts and blood-corpuscles are not uncommon. In uncomplicated cases of the cyanotic induration uræmia is rare. On the other hand, in the cardiac cases with extensive arterio-sclerosis, the kidneys are more involved and the renal function is likely to be disturbed.

III. ANOMALIES OF THE URINARY SECRETION.

1. HÆMATURIA.

The following division may be made of the causes of hæmaturia:

(1) *General Diseases.*—The malignant forms of the acute specific fevers, such as small-pox, malaria, yellow fever, etc.; scurvy, purpura, and hæmophilia. Occasionally in leukæmia hæmaturia occurs.

(2) *Renal Causes.*—Acute congestion and inflammation, as in Bright's disease, or the effect of toxic agents, such as turpentine, carbolic acid, and cantharides. When the carbolic spray was in use many surgeons suffered from hæmaturia in consequence of this poison. Renal infarction, as in ulcerative endocarditis. New growths, in which the bleeding is usually profuse. Tubercle rarely causes hæmaturia, though at the onset, when the papillæ are involved, there may be bleeding. Stone in the kidney is a frequent cause. Parasites: The *filaria sanguinis hominis* and the *Bilharzia* cause a form of hæmaturia met with in the tropics. The echinococcus is rarely associated with hæmorrhage.

(3) *Affections of the Urinary Passages.*—Stone in the ureter, malignant disease or ulceration of the bladder, the presence of a calculus, parasites, and, very rarely, ruptured veins in the bladder. Bleeding from the

urethra occasionally occurs in gonorrhœa and as a result of the lodgment of a calculus.

(4) *Traumatism.*—Injuries may produce bleeding from any part of the urinary passages. By a fall or blow on the back the kidney may be ruptured, and this may be followed by very free bleeding; less commonly the blood comes from injury of the bladder or of the prostate. Blood from the urethra is frequently due to injury by the passage of a catheter, or sometimes to falls or blows.

And, lastly, there are cases in which hæmaturia occurs for a long time without discoverable cause, particularly in young persons. The health may not be seriously impaired. Gull has characterized, in a happy way, a case of this kind as one of renal epistaxis.

Of special interest is the malarial hæmaturia which prevails in certain districts and has already been considered in the section on paludism.

The *diagnosis* of hæmaturia is usually easy. The color of the urine varies from a light smoky to a bright red, or it may have a dark porter color. Examined with the microscope, the blood-corpuscles are readily recognized, either plainly visible and retaining their color, in which case they are usually crenated, or simply as shadows. In ammoniacal urine or urines of low specific gravity the hæmoglobin is rapidly dissolved from the corpuscles, but in normal urine they remain for many hours unchanged.

Other tests are rarely necessary. The guaiacum test consists of the addition to the urine, in a test-tube, of a drop or two of the tincture of guaiacum and two minims of ozonic ether. A blue color forms at the line of contact of the two fluids and diffuses itself through the ether.

The spectroscopical examination of the urine may show either the single band of reduced hæmoglobin or the double band of oxyhæmoglobin between the lines D and E.

It is important to distinguish between blood coming from the bladder and from the kidneys, though this is not always easy. From the bladder the blood may be found only with the last portions of urine, or only at the termination of micturition. In hæmorrhage from the kidneys, the blood and urine are intimately mixed. Clots are more commonly found in the blood from the kidneys, and may form moulds of the pelvis or of the ureter. When the seat of the bleeding is in the bladder, on washing out this organ, the water is more or less blood-tinged; but if the source of the bleeding is higher, the water comes away clear. In many instances it is difficult to settle the question by the examination of the urine alone, and the symptoms and the physical signs must also be taken into account.

2. HÆMOGLOBINURIA.

This condition is characterized by the presence of blood-pigment in the urine. The blood-cells are either absent or in insignificant numbers. The coloring matter is not hæmatin, as indicated by the old name, hæma-

tinuria, nor in reality always hæmoglobin, but it is most frequently methæmoglobin. The urine has a red or brownish-red, sometimes quite black color, and usually deposits a very heavy brownish sediment. When the hæmoglobin occurs only in small quantities, it may give a lake or smoky color to the urine. Microscopical examination shows the presence of granular pigment, sometimes fragments of blood-disks, epithelium, and very often darkly pigmented urates. The urine is also albuminous. The number of red blood-corpuscles bears no proportion whatever to the intensity of the color of the urine. Examined spectroscopically, there are either the two absorption bands of oxyhæmoglobin, which is rare, or, more commonly, there are the three absorption bands of methæmoglobin, of which the one in the red near *C* is characteristic. Two clinical groups may be distinguished.

(1) **Toxic Hæmoglobinuria.**—This is caused by poisons which produce rapid dissolution of the blood-corpuscles, such as chlorate of potash in large doses, pyrogallie acid, carbolic acid, arseniuretted hydrogen, carbon dioxide, naphthol, and muscarine; also the poisons of scarlet fever, yellow fever, typhoid fever, malaria, and syphilis. It has also followed severe burns. Exposure to excessive cold and violent muscular exertion are stated to produce hæmoglobinuria. A most remarkable toxic form occurs in horses, coming on with great suddenness and associated with paresis of the hind legs. Death may occur in a few hours or a few days. Horses are attacked only after being stalled for some days and then taken out and driven, particularly in cold weather. The affection is common in horses in this country. The form of hæmoglobinuria from cold and exertion is extremely rare. No instance of it, even in association with frost-bites, came under my observation in Canada. Blood transfused from one mammal into another causes dissolution of the corpuscles with the production of hæmoglobinuria; and, lastly, there is the *epidemic hæmoglobinuria* of the new-born, associated with jaundice, cyanosis, and nervous symptoms.

(2) **Paroxysmal Hæmoglobinuria.**—This rare disease is characterized by the occasional passage of bloody urine, in which the coloring matter only is present. It is more frequent in males than in females, and occurs chiefly in adults. It seems specially associated with cold and exertion, and has often been brought on, in a susceptible person, by the use of a cold foot-bath. Paroxysmal hæmoglobinuria has been found, too, in persons subject to the various forms of Raynaud's disease. Many regard the relation between these two affections as extremely close; some hold that they are manifestations of one and the same disorder. Druitt, the author of the well-known *Surgical Vade-mecum*, has given a graphic description of his sufferings, which lasted for many years, and were accompanied with local asphyxia and local syncope. The connection, however, is not very common. In only one of the cases of Raynaud's disease which I have seen was paroxysmal hæmoglobinuria present, and in it epileptic attacks occurred at the same time. The relation of the disease to

malaria is not so close as has been thought by many writers. No doubt it has been frequently confounded with a malarial hæmaturia. The attacks may come on suddenly after exposure to cold or as a result of mental or bodily exhaustion. They may be preceded by chills and pyrexia. In other instances the temperature is subnormal. There may be vomiting and diarrhoea. Pain in the lumbar region is not uncommon. The hæmoglobinuria rarely persists for more than a day or two—sometimes, indeed, not for a day. There are instances in which, even in the course of a single day, there have been two or three paroxysms, and in the intervals clear urine has been passed. Jaundice has been present in a number of cases. According to Ralfe, paroxysmal hæmoglobinuria may alternate with general symptoms of the same character, but associated only with the passage of albumen and an increased quantity of urea in the urine. In such cases he supposes that the toxic agent, whatever its nature, has destroyed only a limited number of the corpuscles, the coloring matter of which is readily dealt with by the spleen and liver, while the globulin is excreted in the urine. The cases are rarely if ever fatal.

The essential pathology of the disease is unknown, and it is difficult to form a theory which will meet all the facts—particularly the relation with Raynaud's disease, which is rightly regarded as a vaso-motor disorder. Increased hæmolysis and dissolution of the hæmoglobin in the blood-serum (hæmoglobinaemia) precedes, in each instance, the appearance of the coloring matter in the urine; but, as Ponfick has shown, the amount of free hæmoglobin must reach a certain grade before it is excreted.

Treatment.—In all forms of hæmaturia rest is essential. In that produced by renal calculi the recumbent posture may suffice to check the bleeding. Full doses of acetate of lead and opium should be tried, then ergot, gallic and tannic acid, and the dilute sulphuric acid. The oil of turpentine, which is sometimes recommended, is a risky remedy in hæmaturia. Extr. hamamelis virgin. and extr. hydrastis canad. are also recommended. Cold may be applied to the loins or dry cups in the lumbar region.

The treatment of hæmoglobinuria is unsatisfactory. Nothing seems to check the occurrence of the attacks. During the paroxysm the patient should be kept warm and given hot drinks. Quinine is recommended in large doses, on the supposition—as yet unwarranted—that the disease is specially connected with malaria. If there is a syphilitic history iodide of potassium, in full doses, may be tried. In a warm climate the attacks are much less frequent.

III. ALBUMINURIA.

The presence of albumen in the urine, formerly regarded as indicative of Bright's disease, is now recognized as occurring under many circumstances without the existence of serious organic change in the kidney.

Two groups of cases may be recognized—those in which the kidneys show no coarse lesions, and those in which there are evident anatomical changes.

Albuminuria without Coarse Renal Lesions.—(a) *Functional, So-called Physiological, Albuminuria.*—In a normal condition of the kidney only the water and the salts are allowed to pass from the blood. When albuminous substances transude there is probably disturbance in the nutrition of the epithelium of the capillaries of the tuft, or of the cells surrounding the glomerulus. This statement is still, however, in dispute, and Senator, Grainger Stewart, and others hold that there is a physiological albuminuria which may follow muscular work, the ingestion of food rich in albumen, violent emotions, cold bathing, and dyspepsia. The differences of opinion on this point are striking, and observers of equal thoroughness and reliability have arrived at directly opposite conclusions. The presence of albumen in the urine, in any form and under any circumstance, may be regarded as indicative of change in the renal or glomerular epithelium, a change, however, which may be transient, slight, and unimportant, depending upon variations in the circulation or upon the irritating effects of substances taken with the food or temporarily present, as in febrile states.

Much attention has been given of late years to the albuminuria of adolescence, or *cyclic albuminuria*, which is also believed to be a functional disorder. A majority of the cases occur in young persons—boys more commonly than girls—and the condition is often discovered accidentally. The urine, as a rule, contains only a very small quantity of albumen, but in some instances large quantities are present. The most striking feature is the variability. It may be absent in the morning and only present after exertion, or it may be greatly increased after taking food, particularly proteids. The quantity of urine may be but little if at all increased, the specific gravity is usually normal, and the color may be high. Occasionally, hyaline casts may be found, and in some instances there has been transient glycosuria. As a rule, the pulse is not of high tension and the second aortic sound is not accentuated.

Various forms of this affection have been recognized by writers, such as neurotic, dietetic, cyclic, intermittent, and paroxysmal—names which indicate the characters of the different varieties. A large proportion of the cases get well after the condition has persisted for a variable period. This in itself is an evidence that the changes, whatever their nature, were transient and slight. In these instances the albumen exists in small quantity, tube-casts are not present, and the arterial tension is not increased. In a second group the albumen is more persistent, the amount is larger, though it may vary from day to day, and the pulse tension is increased. In such instances the persistent albuminuria probably indicates actual organic change in the kidney.

(b) *Febrile Albuminuria.*—Pyrexia, by whatever cause produced,

may cause slight albuminuria. The presence of the albumen is due to slight changes in the glomeruli induced by the fever, such as cloudy swelling, which cannot be regarded as an organic lesion. It is extremely common, occurring in pneumonia, diphtheria, typhoid fever, and even in the fever of acute tonsillitis. The amount of albumen is slight, and it usually disappears from the urine with the cessation of the fever.

(c) *Hæmic Changes.*—Purpura, scurvy, chronic poisoning by lead or mercury, syphilis, leukæmia, and profound anæmia may be associated with slight albuminuria. Abnormal ingredients in the blood, such as bile-pigment and sugar, may cause the passage of small amounts of albumen.

The transient albuminuria of pregnancy may belong to this hæmic group, although in a majority of such cases there are changes in the renal tissue. Albumen may be found sometimes after the inhalation of ether or chloroform.

(d) Albuminuria occurs in certain affections of the *nervous system*. This so-called neurotic albuminuria is seen after an epileptic seizure and in apoplexy, tetanus, exophthalmic goitre, and injuries of the head.

Albuminuria with Definite Lesions of the Urinary Organs.—(a) Congestion of the kidney, either active, such as follows exposure to cold and is associated with the early stages of nephritis, or passive, due to obstructed outflow in disease of the heart or lungs, or to pressure on the renal veins by the pregnant uterus or tumors.

(b) Organic disease of the kidneys—acute and chronic Bright's disease, amyloid and fatty degeneration, suppurative nephritis, and tumors.

(c) Affections of the pelvis, ureters, and bladder, when associated with the formation of pus.

Tests for Albumen.—Both morning and evening urine should be examined, and in doubtful cases at least three specimens. If turbid, the urine should be filtered, though turbidity from the urates is of no moment, since it disappears at once on the application of heat.

Heat and Nitric-acid Test.—The urine is boiled in a test-tube over a spirit-lamp, and a drop of nitric acid is then added. If a cloudiness occurs on boiling, it may be due to phosphates, which are dissolved on the addition of an acid. Persistence of the cloudiness indicates albumen.

Heller's Test.—A small quantity of fuming nitric acid is poured into the test-tube, and with a pipette the urine is allowed to flow gently down the side upon the acid. At the line of junction of the two fluids, if albumen is present, a white ring is formed. This contact method is trustworthy, and, for the routine clinical work, is probably the most satisfactory. A diffused haze, due to mucin, is sometimes seen just above the white ring of albumen. A colored ring at the junction of the acid and the urine is due to the oxidation of the coloring matters in the urine.

Sir William Roberts strongly recommends the *magnesium-nitric test*. One volume of strong nitric acid is mixed with five volumes of the saturated

solution of sulphate of magnesium. This is used in the same way as the nitric acid in Heller's test.

Picric acid, introduced by George Johnson, is a delicate and useful test for albumen. A saturated solution is used and employed as in the contact method. It has been urged against this test that it throws down the mucin, peptones, and certain vegetable alkaloids, but these are dissolved by heat.

For minute traces of albumen the trichloroacetic acid may be used, or Millard's fluid, which is extremely delicate and consists of glacial carbolic acid (ninety-five per cent), 2 drachms; pure acetic acid, 7 drachms; liquor potassæ, 2 ounces 6 drachms.

A quantitative estimate of the albumen can be made by means of Esbach's tube, but the rough method of heating and boiling a certain quantity of acidulated urine in a test-tube and allowing it to stand, is often employed. The depth of deposit can then be compared with the whole amount of urine, and the proportion is expressed as a mere trace, almost solid, one fourth, one half, and so on. This, of course, does not give an accurate indication of the proportion of albumen in the total quantity of urine. For the more elaborate methods the reader is referred to the works on urinalysis.

The above tests refer entirely to serum albumen. Other albuminous substances occur, such as serum globulin, peptones, and hemialbumose. By saturating the urine with magnesium sulphate, the globulin is precipitated, coagulated, and then readily separated from the serum albumen.

Traces of *peptones* are found in the urine in many acute diseases and in chronic suppuration. They are not precipitated by heat or nitric acid, but are thrown down by picric acid and dissolved by heat. If the urine contains peptones, a rose or pinkish tint is formed at the junction of the two fluids when urine is allowed to flow gently into a test-tube containing Fehling's solution. Peptonuria has no clinical significance.

Propepton, or hemialbumose, is not of any practical importance. It was found by Bence-Jones in the urine in osteomalacia, and occurs occasionally in other affections.

Prognosis.—This depends, of course, entirely upon the cause. Febrile albuminuria is transient, and in a majority of the cases depending upon hæmic causes the condition disappears and leaves the kidneys intact. An occasional trace of albumen in a man over forty, with or without a few hyaline casts, and with increased tension and thick vessel walls, usually indicates changes in the kidneys. The persistence of a slight amount of albumen in young men without increased arterial tension is less serious as even after continuing for years it may disappear. I have already spoken of the outlook in the so-called cyclic albuminuria.

Practically in all cases the presence of albumen indicates a change of some sort in the glomeruli, the nature, extent, and gravity of which it is difficult to estimate, so that other considerations, such as the presence of

tube-casts, the existence of increased tension, the general condition of the patient, and the influence of digestion upon the albumen, must be carefully considered.

The physician is daily consulted as to the relation of albuminuria and life assurance. As his function is to protect the interests of the company, he should reject all cases in which albumen occurs in the urine. It is even doubtful if an exception should be made in young persons with transient albuminuria. Naturally, companies lay great stress upon the presence or absence of albumen, but in the most serious and fatal malady with which they have to deal, chronic interstitial nephritis, the albumen is often absent or transient, even when the disease is well developed. After the fortieth year, from a standpoint of life insurance, the state of the arteries is far more important than the condition of the urine.

IV. PYURIA (*Pus in the Urine*).

Causes.—(1) *Pyelitis and Pyelonephritis.*—In large abscesses of the kidney, pyonephrosis, the pus may be intermittent, and for days or even weeks the urine is free. In calculous and tuberculous pyelitis the pyuria is usually continuous, though varying in intensity. In these cases, as a rule, the pus is mixed with the urine, which is acid in reaction. In the early stages of pyelitis the transitional epithelium may be abundant, but is not in any way distinctive. In the pyelitis and pyelonephritis following cystitis the urine is usually alkaline, and contains more mucus; micturition is usually more frequent, and the history points to a previous bladder affection.

(2) *Cystitis.*—The urine is alkaline, often fetid, the pus ropy, and the amount of urine greatly increased. The ropy, thick mucus usually comes with the last portions of the urine. Triple phosphate crystals may be present in the freshly passed urine.

(3) *Urethritis*, particularly gonorrhœa. The pus appears first, is in small quantities, and there are signs of local inflammation.

(4) In *leucorrhœa* the quantity of pus is usually small, and large flakes of vaginal epithelium are numerous. In doubtful cases, when leucorrhœa is present, the urine should be withdrawn by a catheter.

(5) *Rupture of Abscesses into the Urinary Passages.*—In such cases as pelvic or perityphlitic abscess there have been previous symptoms of pus formation. A large amount is passed within a short time, then the discharge stops abruptly or rapidly diminishes within a few days.

Pus gives to the urine a white or yellowish-white appearance. On settling there is a heavy grayish sediment, and the supernatant fluid is usually turbid. The sediment is often tenacious and ropy. The reaction is generally alkaline, and the odor may be ammoniacal even when passed. Examination with the microscope reveals the presence of a large number of pus-corpuscles, which are usually, when the pus comes from the blad-