DIAGNOSIS BY THE URINE

MEMMINGER

THIRD EDITION

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OR

THE PRACTICAL EXAMINATION OF URINE WITH SPECIAL REFERENCE TO DIAGNOSIS.

BY

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ETC., ETC.

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TO

Students of Medicine and Practitioners at Large

THIS LITTLE VOLUME IS DEDICATED.

THE ATTEMPT AT SIMPLICITY OF ARRANGEMENT AND OF STYLE IT IS HOPED WILL COMMEND IT TO THEM, AND BE THE MEANS OF INCREASING THEIR KNOWLEDGE AND DIMINISHING THEIR LABOR IN THIS SPECIAL DEPARTMENT OF SCIENCE.

PREFACE TO THIRD EDITION

The author, in carefully revising this third edition, has added a little more matter, but has kept to the original idea of not making the book too bulky. Tests have been added here and there which seemed to him of service in his work, a reliable and practically useful method for the quantitative estimation of uric acid, a quantitative method for chlorids, a general outline of the anatomy of the kidneys and a short method for estimating the permeability of the kidneys.

He has seen, too, nothing since the publishing of the second edition to change his views in regard to the chapter on the absolutes and relative absolutes of solids and urea in urine; far from it, in this edition he calls forth caution to those who pass urine under the name of renal insufficiency, which is constantly free of albumin, but in which the solids and urea are as stated in that chapter. He too feels that the views expressed by him in that edition as to the significance of tube-casts have been but verified by his work since.

He hopes, then, this edition will meet with the same favor from his critics as previous editions, and that the little volume may continue to be a help to students and a safe guide to the busy general practitioner.

THE AUTHOR.

34 MONTAGUE STREET, CHARLESTON, SOUTH CAROLINA.
June, 1908.

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INTRODUCTION.

The urine is the secretion of the kidneys, and, normally considered, is a solution of tissue which has undergone retrograde metamorphosis. The process by which this is brought about is a double one: filtration, which occurs chiefly in the Malpighian capsules of the kidney, and excretion, which is brought about by means of the epithelial lining of the tubules of the kidney. Although this is true for all practical purposes, still the lines are not so accurately defined as this, a certain though small proportion of the excretion taking place through the Malpighian tufts, and, conversely, a certain percentage of water being excreted along with the solids by means of the epithelium of the tubules. The average composition of this fluid is as follows:

Total solids, ...	60	to	65	gm.
Urea, ...	30	"	35	"
Uric acid, ...	0.5	"	0.8	"
Chlorids, ...	10	"	12	"
Phosphoric acid, ...	2.5	"	3	"
Earthy phosphates, ...	1	"	1.3	"
Sulphuric acid, ...	1.5	"	2.5	"
Hippuric acid, ...	0.25	"	0.5	"
Creatinin, ...	0.5	"	1	"

In disease the urine, besides showing deviations in the normal constituents and physical characteristics, contains albumin, sugar, biliary coloring-matter, acids and fats, uroerythrin (red coloring-matter), ammonium sulphid, blood, leucin and tyrosin, carbonate and oxalate of calcium, carbonate of ammonium, cystin, xanthin, pus, epithelium, spermatozoa, and fungi.

Kidneys.—The kidneys are two large glandular organs located in the upper and posterior walls of the abdominal cavity on either side of the spine—the left kidney is ordinarily longer than the right and slightly narrower than the right. Each kidney is about four inches long, two inches wide and one inch thick; they weigh about four to five ounces each, the male kidney being about two and a half drams heavier than that of the female, the left kidney, too, is about six and one-half grams more in weight than the right. The kidney in form represents the haricot or kidney bean; they are situated deep in the loins. The inner border at its upper part is about one inch from the middle line of the body, the outer border at its lowest part three and three-fourths inches from the same line. The upper border corresponds with the space between the eleventh and twelfth ribs, and the lower with that of middle of the third lumbar vertebra. A horizontal line then passed through the umbilicus would lie just below the lower borders of both kidneys, and a vertical line drawn perpendicularly upward through Poupart's ligament to the costal arch would pierce through the length of each kidney. The kidneys then rest on the crura of the diaphragm on the anterior lamella of the posterior aponeurosis of the transversalis muscle as also on the psoas muscle. The right kidney is slightly lower than the left, due to the location of the liver, to which it touches by its suprarenal capsule.

The kidneys are surrounded by a thick layer of adipose tissue, held in the meshes of a loose areolar tissue and which constitutes the tunic adiposa.

· The capsule of the kidney is a smooth, closely fitting membrane which covers the organs and is attached to it by elastic fibers, and adheres by means of connective tissue and capillary blood-vessels; it can be separated in the healthy kidney, but in diseased states of the organs it brings with it when torn off, small particles of kidney substance. The kidney is most liberally supplied with blood; the renal artery is of large size and arises from the aorta slightly below the origin of the superior mesenteric artery, the right usually a little lower than the left, and both break up then into small capillaries each of which abruptly terminate in a glomerulus of short capillaries, inclosed in the capsule of Bowman. The renal vein is short and wide and the nerves of the kidney consist of filaments from the sympathetic and cerebro-spinal systems.

DIAGNOSIS BY THE URINE.

CHAPTER I.

PHYSICAL CHARACTERISTICS OF URINE IN HEALTH.

AMOUNT.

The quantity of urine passed in twenty-four hours by one in health is dependent upon so many circumstances, at times controlled by mental, emotional, and physical causes, that it is hard to give an accurate norm. After most careful observations, however, extending over years, the author has arrived at the following estimate of quantities as fairly representing, in a vast number of cases, a condition of health in the adult:

1. A winter average of 1500 c.c.

2. A winter occasional average of 2000 c.c., depending almost entirely on sudden cold changes, accompanied frequently by moist, easterly winds.

3. A winter minimum of 1200 c.c.

4. A summer average of 1100 c.c.

5. A summer occasional average of 1500 c.c., depending much upon the same conditions as in winter.

6. A summer minimum of 900 c.c.

The average quantity, then, of urine passed by one in health in the twenty-four hours in winter is 1500 c.c., or 50 fluidounces. Most is passed in the afternoon, less in the morning, and least at night. Of course, the amount passed will be much influenced by the causes already mentioned, as also by the quantity of fluid taken into the system; but the above is the general average for winter in health, and a variation of 500 c.c. less than the maximum, or 500 c.c. more than the minimum, must be allowed, not constituting in this variation a condition of disease.

SPECIFIC GRAVITY.

The specific gravity of normal urine for the twenty-four hours has quite an extensive range; and, as in the case of quantity, so have our observations shown us that quite a different range is to be observed between the specific gravity of urine passed in winter and that passed in hot weather.

Winter urine has a general average of 1.018, and varies, according to the quantity of water passed, from 1.013 to 1.022.

Summer urine has a general average of 1.023, and varies, according to the quantity of water passed, from 1.017 to 1.030.

The urine, too, of children shows very different

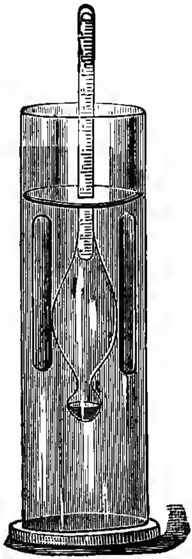

FIG. 1.—Urinometer.

specific gravities in health and disease from that of the adult; and, in the experience of the writer, has a normal specific gravity in winter varying from 1.008 to 1.012, and in summer, from 1.012 to 1.017.

The water solids and urea will be found one-third less than in the adult; therefore calculations made as to the normal and relative absolutes of solids and urea, as indicating a state of health or disease, must be made with this understanding.

In my experience, also, the urine of old men and old women shows a corresponding similarity to that of very young persons.

The specific gravity is most easily obtained by means of the urinometer, as follows:

Fill a small standing glass cylinder four-fifths full of the urine, remove all froth by means of filter-paper, and place in cylinder the urine float (hydrometer)—do not allow the float to touch sides—and read depth to which hydrometer sinks; the number so found, if the urine has temperature of 60° to 62° F., represents the specific gravity. If the temperature is above or below, wait until it becomes 60° or 62°, and then make your observations.*

From the specific gravity we can approximately, and for all usual clinical purposes, calculate the solids excreted in the twenty-four hours. The rule is as follows: Multiply the decimal of the specific gravity by 2.33 and the result will represent the weight of solids contained in 1000 c.c. of urine; hence we can, if we have the quantity of urine passed in twenty-four hours, estimate the weight of solids contained in the

* Hydrometers carrying temperature-chart on them can be procured of Messrs. Eimer & Amend. of New York.

whole. For example, patient passed 3000 c.c. of urine of specific gravity 1.015; therefore $15 \times 2.33 = 34.95$ grams of solids contained in 1000 c.c. Consequently, to arrive at amount in 3000 c.c. we say:

$$1000 : 3000 :: 34.95 : x$$
$$x = 104.85 \text{ gm.}$$

If a more accurate determination of the solid matter is desired, the same is readily attained by evaporating a definite quantity of urine on the water-bath, drying at 212° F. the residue thus obtained, and then, by means of the chemic balance, ascertaining its weight.

CONSISTENCE.

Normal urine is a thin and easily dropping fluid, and only becomes viscid when it has undergone or is undergoing some pathologic change. It foams on being shaken, but the same subsides and vanishes very soon after; if, however, it contains sugar or albumin, the foam remains for a long time.

COLOR.

The color of normal urine is a bright amber or sherry-wine yellow if the entire quantity for the twenty-four hours (1500 c.c.) is taken; if not, the color varies in consequence to the time of day taken—on rising in the morning it is darker, and during the day, and particularly after dinner, the tint is less strong.

TRANSPARENCY AND ODOR.

Normal urine is *always* clear and transparent, and shows, on standing, a cloud of mucus; this mucus is only mechanically suspended in the urine, and not in any wise dissolved; the odor is sharp and slightly aromatic, and its cause is at present unknown.

REACTION.

The reaction of normal urine for the twenty-four hours is *slightly* acid, the same being caused by the presence of acid phosphates of the alkalies. To determine whether or not urine is acid, moisten a slip of blue litmus-paper with the secretion, and if it changes from blue to red, the urine is acid; should the urine show an excessive degree of acidity, it is a sign that the urine is passing from a normal state to an abnormal one. Having now considered the general physical characteristics of normal urine, let us pass on to consider a deviation from these and note those points which mark the beginning of disease in the urinary organs.

CHAPTER II.

DEVIATIONS IN THE PHYSICAL CHARACTERISTICS OF URINE IN DISEASE.

AMOUNT.

As has been previously said, the amount of urine passed in health in the twenty-four hours is about 1500 c.c., or say 50 fluidounces. If the quantity is much increased, and *habitually* so, we have a condition of things known as polyuria; if, on the other hand, it is much diminished, a condition known as oliguria; and if entirely suppressed, anuria.

Polyuria may be either physiologic or pathologic; in the first instance it is called urina potus (from excessive taking-in of fluids), and in the second hydruria or diabetes. To make a differential diagnosis in these cases, the total quantity of solids passed in the twenty-four hours is requisite, so this brings me at once to the consideration of the deviations in specific gravity which constitute disease.

SPECIFIC GRAVITY.

The specific gravity of normal urine, as has been said, varies much, being in winter at times 1.013, and again 1.022, but averaging about 1.018. As in case, however, of the total quantity of urine passed in the twenty-four hours it was shown that an allowance, excessive or the reverse, to the amount of 500 c.c. must be made, so in the specific gravity a variation of a few degrees either way by *itself* indicates nothing; when, however, a urine *habitually* falls below the winter minimum, or goes above its maximum, it is an evidence in the first instance of a pathologic hydruria, and in the second of a condition known as polyuria.

This latter condition is commonly called diabetes, and is of two kinds: Diabetes insipidus, where the solids are all increased, but no sugar is present; when sugar is found it is called diabetes mellitus. As examples of these different kinds of urine, I will say that in the first class of urines—the true pathologic hydrurias—we have a urine of low specific gravity, 1.002 or so, and large quantities of water, 4000 to 6000 c.c. On calculating the total solids, it will be found that they are much diminished, whereas the water is in a corresponding degree increased above the normal. In the second class of urines the hydrometer shows a specific gravity of 1.025 to 1.030, and the quantity of water is also considerably increased, being 1500 c.c. to 2500 c.c. in the twenty-four hours. In these urines, if no sugar is found, the increase in solids is most surely due to excessive quantity of urea or else to phosphoric acid. If the increase of solids is due to an increase of phosphates, it is called phosphaturia; when, however, sugar is the cause of the increased specific gravity, it is called diabetes mellitus.*

COLOR.

Deviations in color mark the beginning of pathologic changes going on in the urinary organs. Colorless urines of low specific gravity and excessive increase of water—4000 c.c. to 6000 c.c.—evidence a neurotic affection. Colorless urines, again, with habitual low specific gravity—1.010 to 1.005—but not necessarily an increase of water, point to atrophy of the kidney as the probable cause; as the disease advances, however, the water increases beyond the normal. Urines also appear dark yellow-red, bright garnet-red, dark brown, and greenish yellow. The color in dark yellow-red urines is due either to blood or else to a coloring-matter called uroerythrin. As the consideration of the morbid constituents found in urine is taken up separately, together with the consideration of the other colors named, I will defer this until later on, and will consider urines colored garnet-red, as

* A condition known as chyluria, and simulating phosphatic diabetes, sometimes occurs; the urine here is thick and heavy, and appears as a milky white liquid. It coagulates readily on being heated, as it contains much fibrin, and the coagulum does not dissolve on the addition of acetic acid, as would the phosphates; this reaction, therefore, together with the presence of fat, renders the differential diagnosis in these cases easy.

this color is generally due to foreign vegetable coloring-matters. Take three drams of clear urine (filter, if not clear); add to the same in a test-tube ten drops of nitric acid (strong), and boil for a minute; if the red is not due to pathologic changes in the urine the color will disappear, and on the addition of an alkali it will return, to be again dissolved when the urine is once more acidified by nitric acid and heated.

TRANSPARENCY AND ODOR.

Normal urine being clear and transparent, with only floating particles of mucus, a urine deviating much from this is an indication of disease in the urinary organs. To determine this, take a portion of the twenty-four hours' urine, place in a glass cylinder, and stand same on piece of white paper; by this we can determine not only the amount of floating matter in the urine, but also, from the same specimen, the color, specific gravity, odor, and reaction. If the urine by this procedure appears thick and cloudy, it may be due simply to an insufficiency of water, or else to morbid changes. To differentiate these conditions, heat the urine in a test-tube, and if all dissolves, the turbidity was due to urates; if, on heating, instead of clearing up it becomes more turbid, add a few drops of acetic acid, and if it now clears up, it is an evidence that the urine was too concentrated, and therefore the solids precipitated out.

If, finally, the urine appears with the addition of acid and heat as it does without them, the turbidity is surely due to bladder or kidney detritus, and may therefrom be taken as an indication of disease.

REACTION.

Normal human urine shows in the twenty-four hours' urine a *slightly* acid reaction; if, however, the urine is taken at different periods of the day, it will be found that the acidity varies. Shortly after a meal the urine is slightly alkaline, but after a while it again rights itself. If the urine shows too decided an acid reaction it is abnormal, and marks either an excessive quantity of uric acid present or else an acid condition of the urine caused by free acid. This latter condition is easily determined by taking three drams of the twenty-four hours' urine (clear; and, if not, filtered so as to make it so), placing it in a test-tube, and pouring into it one-half the quantity of a strong solution of the hyposulphite of sodium. If free acid be present, a turbidity immediately forms whose density is in proportion to the quantity of acid present. This reaction is caused by the precipitation of sulphur, the free acid having united with the sodium of the salt.

The reaction, again, of urine may deviate in the opposite direction, constituting an alkaline urine, and therefore indicating disease. There are two ways in which the urine may become alkaline, and it is very important, from a clinical standpoint, to name and understand them. The first is from fixed alkali and the second from volatile (carbonate of ammonia).

Both forms of alkaline urine change red litmus-paper to blue on being moistened; but in the case of fixed alkali, litmus-paper, on being dried, does not regain its red color, whereas in the case of urine rendered alkaline from volatile alkali, the red litmus-paper regains its color on being dried. Urine showing the presence of volatile alkali is *always* an evidence of disease (inflammation) of some part of the genito-urinary apparatus.

If there be both fixed and volatile alkali present in the urine, the above test will give a negative result; so important, however, is it for us to know whether or not volatile alkali is present, and therefore if inflammation is to be excluded, that we proceed as follows: Place 100 c.c. of the urine in a glass flask, to which is fitted a cork; on inserting the cork, allow a slip of moistened red litmus-paper to be placed against its side and extending down into the flask, but not reaching into the urine; heat the flask gently (*do not boil*), and if any carbonate of ammonia is present, the red litmus-paper will immediately turn blue. I suppose it is needless for me to caution that this test must *always* be applied to *fresh* urine.

Urines alkaline from fixed alkali generally effervesce on the addition of an acid, and though not indicating any particular derangement of the kidneys, are usually met with in enfeebled conditions of the body in which the respiratory act is performed with difficulty, and thus carbonic acid is allowed to accumulate in the system; also whenever the bile is diminished, or when there is a tendency to fermentative changes in the stomach or intestines. The dyspepsia which accompanies this kind of urine is attended with great depression of spirit; flatulence is marked, the bowels confined, and the skin dark and sallow, showing evident derangement of the liver.

CHAPTER III.

DEVIATIONS IN THE NORMAL CHEMIC COMPOSITION OF URINE IN DISEASE.

UREA.

From a clinical standpoint, of all the normal constituents found in human urine we need only consider urea, uric acid, chlorids, and phosphates of the alkalies and alkaline earths. Urea is the main solid which is passed in the urine, and averages from thirty to thirty-five grams (460 to 540 grs.) in the twenty-four hours. It is a diureid, and has the formula CON_2H_4.

The quantity of urea excreted from the body in the twenty-four hours is much influenced by: (1) The amount of nitrogenous food supplied the system; (2) amount of active exercise taken during the day; and (3) the quantity of water drunk. If the three indications are all met, then urea increases very much in the urine. If, however, the amount increases and the three conditions mentioned are not given, why then the increase is an approximate evidence of the waste of the system. This takes place in all fevers and wasting diseases, and as long as the liver and kidneys remain intact, the former to manufacture and the latter to convey away retrograde tissue products, why then the estimate from day to day of the urea in the urine will be a pretty fair approximate estimate of the wearing away of tissue, and consequently of the loss of vital force. When urea under the before mentioned conditions instead of being increased, is found to have decreased, it is then an evidence of either a diseased condition of the liver or kidneys. It is surprising to see, however, how low the urea finally runs in some cases before the fatal hour arrives. I have notes of a case treated for two months, and on no occasion during this time was there more passed than 13.52 grams in the twenty-four hours. We can safely say, therefore, that when urea in the urine of the twenty-four hours habitually falls below twenty grams in the case of an adult of active pursuits and well-nourished body, we should suspect disease of the liver or else of the kidneys.

ESTIMATION OF UREA.

The manner in which the estimation of urea is made is very simple and sufficiently accurate for clinical purposes. It is founded on the decomposition of urea by the action of such an agent as the hypobromite of soda:

$$H_4CON_2 + 3NaBrO = N_2 + CO_2 + 2H_2O + 3NaBr.$$

The results would be a little low if urine contained urea alone, but since we find in it also uric acid, urates, and kreatinin, these, in giving up their nitrogen, make up for the loss, and thus nicely counterbalance this source of error. The manipulation of the process is as follows: We advise for use the most excellent

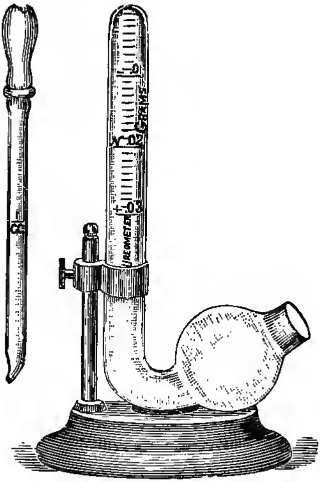

FIG. 2.—Ureometer of Dr. Doremus.

ureometer designed by Dr. Charles Doremus, of New York, to whom, allow me to say, the profession owes a debt of gratitude for making so simple a process which has heretofore been so the reverse. These ureometers are graduated according to the French and English systems, respectively; the manipulation with either is the same, but the calculations being different, I deem it best to describe the procedure with each.

1. Make a solution of sodium hydrate, 100 grams to 250 c.c. of distilled water. Keep this in bottle with rubber stopper.

2. Make solution of hypobromite by adding one c.c. of bromin to ten c.c. of sodium hydrate solution and diluting with ten c.c. of distilled water.

It is convenient, instead of making this solution previously (which does not keep long), to pour directly into the ureometer the sodium hydrate solution until the liquid rises to the mark "=," which is on each ureometer; by means, now, of a little nipple pipette, which goes with each set, measure out one c.c. of bromin, add this to the hydrate solution, and, after the bromin has all gone into solution, dilute by pouring in water so as to fill the long arm and bend of the ureometer; see, now, that the instrument is full, and thoroughly luted at the bend in the arm—which is easily attained by tilting and then raising again until all air has been expelled—and you have a thorough and complete mixture.

The instrument is now in condition for your test, and the remarks made are true for the English as well as for the French instrument I am describing.

Draw up by means of the pipette one c.c. of urine to be tested; if the urine contains much albumin, free it of the same by heating, but not boiling; if the quantity, however, is small, disregard it, and pass the pipette into the ureometer as far as the bend, and compress the rubber on end of pipette, thereby causing urine to ascend in hypobromite slowly; on so doing, there is great disengagement of gas (carbonic acid and nitrogen), and after the disturbance is over and several minutes are allowed to elapse, the volume of nitrogen may be read, as the column of liquid in the ureometer will be depressed just in proportion to the quantity of evolved gas, the carbonic acid gas being all absorbed by the hydrate of sodium. *Each* division mark on the ureometer indicates 0.001 gram of urea in one c.c. of urine. The quantity, therefore, of urea voided in the twenty-four hours is ascertained by multiplying the result of the test by the number of cubic centimeters of urine passed during that period. When the English ureometer is used—divided, as it is, into grains—the solutions are prepared and calculation made as follows:

1. Make a solution of sodium hydrate, six ounces to the pint of distilled water; keep this in a bottle with rubber stopper.

2. Make solution of hypobromite of sodium as previously described, and proceed exactly in the same way with the urine, etc.

Each division on this ureometer indicates one grain of urea in one fluidounce of urine; the quantity, therefore, of urea voided in the twenty-four hours is ascertained by multiplying the result of the test by the number of ounces of urine passed during that period.

URIC ACID.

Uric acid is found only in small quantity in human urine, and when occurring in excessive amounts, its great insolubility in water causes it at once to crystallize out. This, unfortunately, *frequently* takes place in the kidneys, and thus concretions are lodged there which form foci of irritation, and finally, if allowed to continue, eventuate in one or other of the chronic forms of nephritis.

Uric acid, also in union with sodium, potassium, and calcium, is often found in large quantities in urine, principally, we may say, in the beginning of fevers and in all conditions in which the system is subjected either to a higher temperature for a short time, or else to a lower temperature for a longer period. Along with these urates is precipitated a coloring-matter, called uroerythrin; this coloring-matter is red, and gives to uric acid and urate deposits a rosy-red tint—the so-called brick-dust deposit, so often observed in the *pot de chambre* in the morning. If this deposit habitually occurs in the urine of persons not suffering from fever, it is a sign that the liver is at fault, and that the gouty or rheumatic gout diathesis is being established. The presence of uroerythrin, uric acid, and urates is most easily ascertained.

If these are present, the urine will be turbid, the

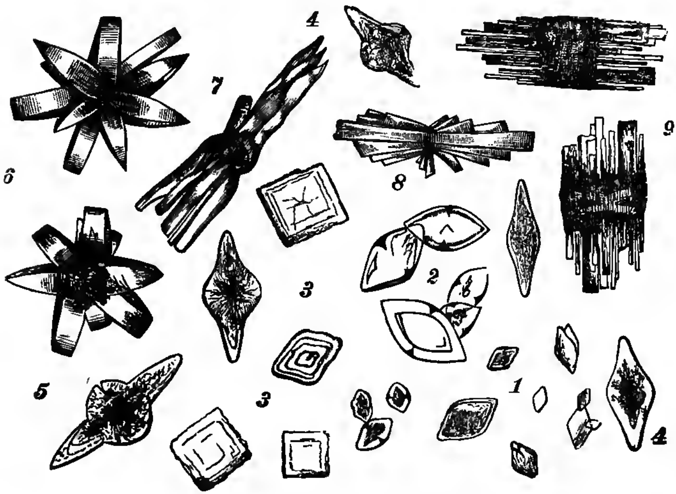

FIG. 3.—Forms of Uric-acid Crystals.

1. Rhombic plates. 2. Whetstone forms. 3. Quadrate forms. 4, 5, Prolonged into points. 6, 8. Rosettes. 7. Pointed bundles. 9. Barrel forms precipitated by added hydrochloric acid to urine.

urates will clear up on being heated, and the uric acid will be dissolved if to the sediment is added an alkali. To determine the presence of uroerythrin, take three drams of urine, place in a test-tube, add one to three drops of a solution of the acetate of lead, and if it is present, a precipitate of a *rosy pink* (flesh colored) will immediately fall. When uric acid occurs in abnormal amounts, it will be found, if the case is one of *true* lithemia, that all the other solids are diminished; this state of things points strongly to grave diseases of the liver, acute yellow atrophy, cirrhosis, and cancer. If the urine for the twenty-four hours is near the normal amount, and uric acid crystallizes out a short time after standing, it is in abnormal quantity. Its detection is readily made in the following manner: Filter, if the urine is not clear, 100 c.c.; acidify with ten c.c. of strong hydrochloric acid, allow it to stand, and after twelve hours uric acid will be found crystallized, and can be verified by either the microscope or else by the murexid test, which is performed as follows: Take a few of the crystals; place on a watch-glass, add a few drops of nitric acid, and apply heat gently; after thus attaining solution of the uric acid, dry carefully over the flame, and to the dry and cool mass add a few drops of ammonia; if the crystals be uric acid, a most magnificent purple color will rapidly spread over the touched mass.

ESTIMATION OF URIC ACID, BY RUHEMANN'S IODINE METHOD.

This process has been somewhat criticized in regard to its absolute accuracy, but we may add, it gives at times absolutely accurate results and at all times quite near enough the truth when linked with the ease of execution, to make it, in our opinion, of great service to the clinician. Ruhemann's uricometer is to be recommended and his reagent solution consists of iodine 1.5 grams, potassium iodid 1.5 grams, and 15 grams of absolute alcohol in 185 c.c. of water.

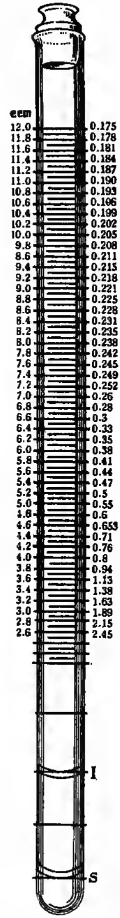

FIG. 4. Ruhemann's Uricometer. (From Lenhartz).

Carbon bisulphid is made to fill the instrument to the first line marked S, and on this is placed by means of a pipette the reagent solution until it stands on the next mark, I, on the instrument. The urine, now brought to the temperature of 65° Fahrenheit, is run in by pipette until it stands at the lower part of the graduated scale marked 2.45. The open end of the uricometer is now closed by the glass stopper and the tube vigorously shaken. The carbon bisulphid assumes a dark brown color, the stopper is removed and more urine added and the process of shaking repeated in same way until just enough urine is added to make the carbon bisulphid become a pure white.

Read now the scale from the surface of the liquid in the tube and the graduations will show at once the amount of uric acid in grams per every 1000 c.c. of urine.

If albumin, pus or blood be present they must be removed by heat, and if the urine is alkaline it must first be made slightly acid with acetic acid. Should also the urine contain less uric acid than the instrument is gauged for, add the reagent iodine solution to the line half way between I and S and read, dividing values by 2.

CHLORIDS.

In the urine of adults the chlorids consist almost entirely of chlorid of sodium, and the average quantity passed in twenty-four hours is between twelve and thirteen grams; consequently it ranks next to urea as the principal constituent in urine. The quantity of chlorids present is subject, as with the other constituents, to fluctuations; when, however, the average falls much below the figures just given, it is a sign of disease of the kidneys, or else of the final stage of some lung trouble or continued fever. Whenever, in pneumonia, the chlorids leave the urine, the case must be regarded as very serious. In cases of chronic nephritis the regular and *habitual* falling-off of chlorid of sodium in the urine gives to the case a serious and grave aspect. The chlorids are not increased in pathologic urines, but are sometimes found in larger quantities than usual when a salt diet is instituted.

To determine whether they are in normal or diminished quantity, take *two ounces* of urine, filter if not perfectly clear, and if albumin is present heat with nitric acid and filter. Take the filtrate in this case, or, if albumin is not present, the clear urine, and acidify with nitric acid; add to it *four* drops of a solution of nitrate of silver—strength one part $AgNO_3$ to eight parts H_2O—and if chlorids are in normal quantity ($\frac{1}{2}$ of one to one per cent.) thick curdy masses of chlorid of silver (AgCl) immediately fall to the bottom of the test-glass. If, on the other hand, the urine contains a small quantity of chlorid—say $\frac{1}{8}$ to $\frac{1}{10}$ of one per cent.—the solution (urine, etc), after the addition of the silver nitrate, shows only a cloud, and instead of the thick masses falling to the bottom, which do *not mix* readily with the urine, we have a solution of milky and turbid appearance.

The gravimetric determination is made as follows: Make a decinormal solution of silver nitrate

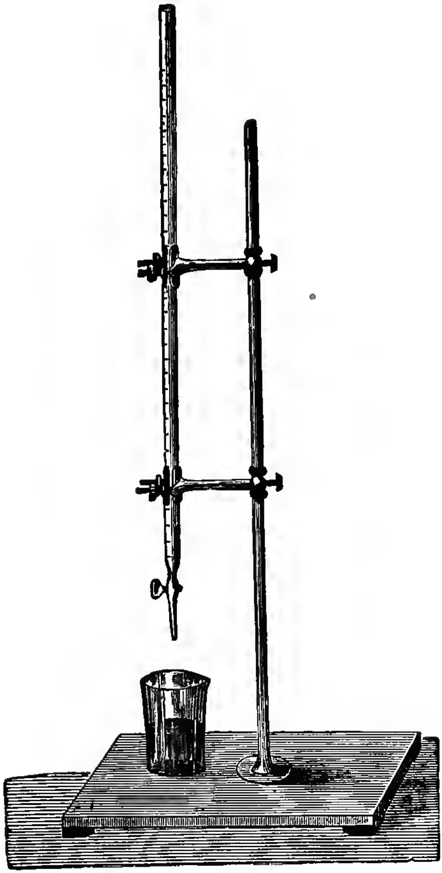

FIG. 5.—Graduated Burette.

($AgNO_3$) 17 grams to 1000 c.c. distilled water. One c.c. of this solution is equal to 0.00584 grams of sodium chlorid (NaCl).

Measure out 10 c.c. of clear urine free of albumin and to it add 70 c.c. of water. If the urine is high colored, oxidize it first by evaporating to dryness the 10 c.c. with a few crystals of permanganate of potassium in a procelain evaporating dish, heating thoroughly; take up with a little nitric acid, dilute with water and add to it in this case a few drops of a strong solution of the bichromate of potassium, or if not high colored, directly and titrate drop by drop with the decinormal solution of $AgNO_3$ until the urine shows a faint pink color indicating that silver chromate is being formed. Multiply the number of cubic centimeters run from the burette by 0.00584 and the result will represent the amount of NaCl in 10 cubic centimeters of urine. Normal urines require about 10 to 14 c.c. to every 10 c.c. of urine.

Example: Patient passed 1500 c.c. in 24 hours; 10 c.c. of this urine was titrated with 14 c.c. of $AgNO_3$ solution, therefore $0.00584 \times 14 = .08176$ gram NaCl in 10 c.c., therefore .008176 in 1 c.c., which, multiplied by 1500 c.c. gives 12.25 grams NaCl.

PHOSPHORIC ACID.

The amount of phosphoric acid passing from the system in the course of twenty-four hours is, as we have said, 2.5 to 3.0 grams, and is distributed among the bases—lime, magnesia, soda, and potassa. Two-thirds are in combination with the oxids of the alkalies, and the remaining one-third in union with the oxids of the alkaline earths. The alkaline phosphates are extremely soluble and are *never* deposited from the urine; on the other hand, the earthy phosphates are only held in solution by the acid of the urine, and so soon as this is changed to a neutral or alkaline state a deposition takes place. To approximately determine the quantity of phosphoric acid in the urine: estimate, by rule already given, the total quantity of solids in the urine, expressed in grams; then by the hypobromite method the total quantity of urea, expressed also in grams; to this add eighteen grams, and subtract the same from the total solids, and the quotient divided by four will give the approximate quantity of phosphoric acid (P_2O_5) passing from the body. Thus, for example, the total quantity of solids found in a certain specimen of urine was 89 grams, the quantity of urea was found to be 32 grams, hence, $32+18=50$, therefore, $89-50=39$, which divided by 4 gives 9.75 grams as the daily elimination of phosphoric acid in this case. This condition is known as phosphaturia or phosphatic diabetes, and as much as 8, 10, or 12 grams of phosphoric acid pass away in the twenty-four hours. Urines of this class resemble closely the urine of diabetes mellitus—high specific gravity; usually a normal quantity of water; acid reaction, and an excessive or normal quantity of urea. Should, then, a urine show these characteristics, and the approximate quantitative test for phosphates, as just explained, show their excessive amount, an accurate gravimetric determination of the phosphoric acid should be made. To this end measure out 50 c.c. of clear urine; if albumin is present, precipitate out by nitric acid and take filtrate. Supposing, therefore, we have 50 c.c. of clear urine: add to it 50 c.c. of strong sulphuric acid and 100 c.c. of water, boil in a beaker for a few minutes and then add a teaspoonful of the nitrate of ammonia (in crystals); while still hot add a nitric-acid solution of molybdate of ammonia, adding this in excess; stir well, boil a few minutes, and cast on a tarred (weighed) filter-paper. Wash yellow precipitate two or three times with molybdate of ammonia solution; dry at 212° F. in a steam oven, and weigh precipitate and paper; deduct weight of latter from former (precipitate and paper), and the result will give the weight of the precipitate of the phosphomolybdate of ammonia; this multiplied by 3.142 gives the equivalent quantity of phosphoric acid, which in our case represents the quantity in 50 c.c. of urine. To find, therefore, the quantity passed in the twenty-four hours is but a simple calculation; for example:

Amount of urine passed in the twenty-four hours was 2000 c.c.; 50 c.c. were taken for analysis, and the absolute quantity of phosphoric acid (P_2O_5) in the phosphomolybdate of ammonia precipitate was found to be 0.25 grams; consequently, to arrive at the quantity passed in twenty-four hours we say:

$$50 : 0.25 :: 2000 : x$$
$$x = 10.00 \text{ grams } (P_2O_5).$$

The nitric-acid solution of molybdate of ammonia has the following composition:

Molybdate of ammonia, ...	10 gm.
Solution ammonia, specific gravity 960, ..	40 c.c.
Strong nitric acid, ...	80 c.c.
Water, ...	80 c.c.

Dissolve the salt in the ammonia by the aid of heat, then pour the solution into the nitric acid and water, which have been previously mixed together.

CHAPTER IV.

MORBID PRODUCTS IN THE URINE IN DISEASE.

ALBUMIN.

Albumin, which has an approximate composition of oxygen, 22 per cent.; carbon, 53; nitrogen, 16; hydrogen, 7; sulphur, 2, when found in the urine *habitually* with a *diminished* specific gravity, is an *unfailing* evidence of disease. True, we now and then meet with albumin in the urine of those in health; even here, however, its appearance is only occasional, its quantity small, and *never* attended with *habitual diminished* specific gravity, as is the case in organic disease of the kidneys: this consideration, then, of the specific gravity becomes, when albumin is present, and even when not, an all-important factor in making a differential diagnosis.

The detection of albumin is easily made as follows:

(*a*) **Tests Without Heat.**—*No.* 1. *Acetic Acid and Ferrocyanid of Potassium Test.*—This test, when executed in the manner laid down in this book, will be found to be most delicate, accurate, and reliable, and will, when albumin is present, show *it* and *it alone.* The presence of the ferrocyanid of potassium prevents the precipitation of mucin with the acetic acid, and, again, in the experience of the author, neither peptone, albumose, alkaloids, nor urates are at all affected by it.

The test is applied as follows: Three c.c. of acetic acid, specific gravity 1.04 to 1.045, is mixed with seven c.c. of a solution of the ferrocyanid of potassium, strength 1:15. Twenty c.c. of *clear* urine is now placed in a test-tube, and to it is added, drop by drop, the test solution; on so doing, if albumin be present, an opalescence ensues, the density of which will depend upon the quantity of albumin present. If large quantities be present, the fluid appears milky, with frequently a tinge of green. The adding of the ferrocyanid mixture (test solution), however, should be continued until the entire ten c.c. is consumed. To bring out the reaction more plainly, the tube should be everted several times, holding the thumb at the opening so as to prevent the escape of fluid.

*No. 2. Saturated Solution of Picric Acid.**—Applied in following manner:

Ten c.c. of a saturated solution of picric acid is placed in a test-glass or tube, and on it is gently floated twenty c.c. of *clear* urine. If albumin be present, an opalescence immediately forms, density of which depending upon quantity present. To avoid errors of

* If the urine is neutral or alkaline, make acid with acetic acid before adding the picric acid.

mistaking peptones, etc., for albumin, proceed with the picric acid, and heat as described under (*b*), test No. 1.

No. 3. *Nitric Acid.*—Three c.c. of clear strong nitric acid is placed in a test-glass or tube and on it gently floated the same quantity of clear urine whose specific gravity is not greater than 1.015. If albumin be present, an opalescence ensues just where the urine comes in contact with the acid, the density of which will depend upon the quantity of albumin present. Although urates give somewhat the same haze in this test the author has noted it is only so when the urines are strong and high specific gravity. To determine, therefore, more definitely apply the test with heat as described under (*b*) test No. 2.

No. 4.—The urine is first treated with acetic acid, making acid, concentrated salt or sulphate of sodium solution is then boiled with it using equal parts; if large amounts of albumin and albumose are present a precipitate at once appears, otherwise after heating; and if albumose is also present it goes into solution on being boiled, leaving only the albumin.

(*b*) **Tests with Heat.**—*No.* 1. *Picric Acid.*—Place twenty c.c. of *clear* urine in a test-tube. and heat until it boils; if albumin be present, it will precipitate out, as an excess of phosphates, however, in a urine which is neutral or alkaline will do the same; cool down the tube by plunging into very cold water (icy cold, if possible); add to it, now, slowly, a saturated solution of picric acid, using about ten c.c.; boil again, and finally plunge the tube once more into cold water, and, if a light, medium, or dense opalescence or precipitate is formed, it is albumin.

No. 2. *Nitric Acid.*—Place twenty c.c. of *clear* urine in a test-tube, and heat until it boils; if albumin be present, it will precipitate out, as phosphates may in this test behave as just described with picric acid; plunge the tube into very cold water and then add a few drops of strong nitric acid until acid; boil again, and finally cool down, as already stated, by plunging into very cold water. If albumin be present in small or large quantities, the urine shows, in the first instance, an opalescence, and in the second a decided precipitate.

FIG. 6.—Esbach's Albuminometer.

I may call attention here to what I made, several years ago, the subject of an article in the "New York Medical Journal" that frequently nitric acid, and even picric, when applied in the ordinary way, failed to detect very small quantities of albumin, but that if after boiling the urines in a test-tube it was suddenly plunged into *cold* water, an appreciable show of albumin was seen. This I have, since writing that article, found to take place more frequently in interstitial nephritis than I then thought, and I am now sure that many times when in these cases the urine is reported as having no albumin, it is due to the cause I have here indicated.

The volumetric determination of albumin is made as follows, using one of Esbach's albuminometers: Esbach's solution is also to be recommended as the precipitant, and is made by taking twenty grams of citric acid, ten grams of picric acid, dissolving them in 900 c.c. of hot water, and making up to 1000 c.c.

For analysis, fill the albuminometer up to U (mark designated on each tube) with urine; then fill to the mark R with the test solution, place rubber cork or thumb over the top of the tube, and tilt and raise again several times (do not shake); close the tube with a cork and leave for twelve or eighteen hours. The lines graduated on each albuminometer represent the number of grams in the 1000 c.c. of urine under examination, consequently the line to which the precipitate extends marks at once the quantity of albumin in 1000 c.c.; for example, precipitate extended to line marked 3, and patient passed 1200 c.c. in twenty-four hours, hence:

$$1000 : 1200 :: 3 : x$$
$$x = 3.6 \text{ gm.}$$

The points necessary to note in the conduction of this process are: (1) That the urine to be examined is acid; if not, make so with a few drops of acetic acid.

(2) If great quantities of albumin are present, dilute with one or two volumes of water; of course, the dilution must be taken into account in making the final calculations.*

SUGAR.

The presence of very small quantities of sugar in the urine constitutes a condition known as glycosuria; whereas if large quantities are found it is called diabetes mellitus. The former condition, if *habitual*, is unnatural, and will, if allowed to run on, eventuate in the more formidable complaint. These diseased conditions of the system by no means point to diseases of the kidneys or urinary organs, but really to disease of the liver, or, rather, perverted action therein. Sometimes, also, a diet too exclusively saccharine or starchy in its character will bring about this condition in those susceptible to this malady. The kidney, in ridding itself of this morbid product, becomes irritated, and this irritation extends down the entire canal, and we thus have produced a real polyuria. There are three distinct varieties of this disease as regards grade and prognosis. In the first class we have a urine of high specific gravity—1.030 or

* Turbid urines, which are found to filter with difficulty, either should be shaken first with chloroform or talc powder, and then filtered, or else made slightly alkaline with ammonium hydrate and then filtered; after either one of these procedures the tests for albumin may be applied; seeing, however, that the urine is first made acid with acetic acid.

more—large increase of water, and an increase of all the other solids. In the second class, a urine of even higher specific gravity—1.030 to 1.060—no increase, but often diminished volume of water, and an increase of all the other solids, constituting thus a true baruria. In the third class of cases the urine appears about normal in quantity, a little high in specific gravity—1.025 to 1.030—and there is a small quantity of sugar. In all cases the urine is *decidedly* acid, and undergoes, after standing a short while, putrid (alkaline) decomposition; it is also generally turbid, from the detritus of the urinary organs brought about by the irritating action of sugar on the mucous membranes.

All forms of this disease are grave, but the first two varieties are the most formidable to treat, and nearly always in the young eventuate in an early grave. The test for sugar in the urine is made and applied as follows:

1. *Picric Acid Test.*—This affords an extremely simple and delicate test for sugar (glucose) in the urine, and has the additional advantage of showing at the same time if albumin is present; its reaction with sugar is also not interfered with by the presence of albumin. Take ten c.c. of clear urine, and to it add an equal quantity of a saturated aqueous solution of picric acid; boil, and, after so doing, while still *very hot*, add a few drops of caustic potash or soda solution, making alkaline; if sugar be present, the color changes

to a deep red mahogany-brown, and is not to be confounded with the bright cherry-red which occurs in any urine when treated in this way.

2. *Heller's Test.*—Take a test-tube and place in it two drams of urine; if albumin is present, first rid the urine of it by means of heat; if, also, the color of the urine is dark—which, however, is hardly ever the case in diabetic urines—first treat the urine with a little lead acetate solution, filter the urine thus freed of its color and then take, as said, two drams; add to this one dram of caustic soda or caustic potash solution, and boil; on so doing the earthy phosphates precipitate out, and if they are in large quantities they must be filtered out; if not, their presence is disregarded. The color of the urine, if sugar be present, changes to a lemon-yellow, yellowish-brown, or blackish-brown, according to the quantity of sugar present. Add, now, a few drops of nitric acid; the dark color vanishes, and in its place the odor of burnt sugar is given off.

3. *Nylander's Test.*—Take 2 parts of bismuth subnitrate, 4 of Rochelle salts and 100 of an eight per cent. solution of sodium hydrate. One part of this solution is added to 8 or 9 parts by volume of the urine and the whole boiled for a short time; a grayish coloration of the mixture, after a little becoming deep black, indicates the presence of sugar, depth or faintness of color indicating in a general way the

amount of sugar present. It is well to remember, however, that this test is very delicate and shows smaller quantities of sugar when the urines are not too concentrated. Senna, antipyrin, rhubarb, salicylic acid, chloroform, chloral, camphor, saccharine and terpentine must not be in the urine, as they reduce.

4. *Molisch's Test.*—Take a ten per cent. solution of *a*-naphthol in pure methyl or ethyl alcohol. Mix 2 c.c. with 1 c.c. of urine free of albumin if present; add excess of sulphuric acid, and if sugar be present a deep violet color is produced. Dilute with water. A blue precipitate occurs which is found to be soluble in ether, alcohol, or caustic potash, giving on so doing a yellow solution. This test is very delicate and shows no reaction with urea, uric acid, xanthin, creatinin, indican or hippuric acid.

The gravimetric determination of sugar is effected by the use of Fehling's solution, and depends for its reaction upon the power of glucose to reduce, in alkaline solutions, cupric salts to cuprous—viz., the suboxid Cu_2O. If the urine is clear and *free* from *albumin*, measure out carefully ten c.c.; if it is not, get rid of the albumin by heat, filter, and then measure carefully ten c.c. To this add 190 c.c. of distilled water, and fill a burette with the same. Carefully measure out ten c.c. of Fehling's solution, place in a porcelain basin, add forty or fifty c.c. of distilled water, and apply heat gently. Into this run from the burette,

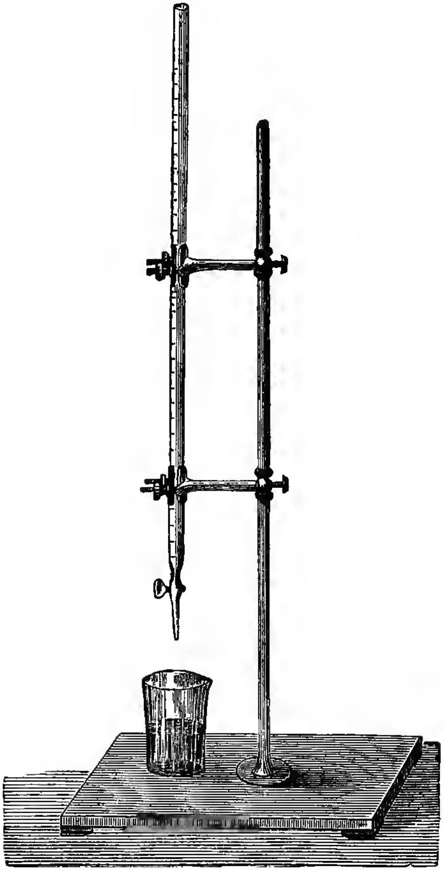

FIG. 7.—Graduated Burette.

carefully, drop by drop, the diluted urine, and on so doing the blue solution will become turbid, gradually losing its color, and in its place will appear yellow, red, and finally a colorless solution. When this is attained it is evident that complete reduction has been effected; to make sure, however, take a few drops of the supernatant fluid from the porcelain basin, place in test-tube, and add a few drops of acetic acid and then a little ferrocyanid of potassium (solution); if no brown coloration ensues, the process is completed; if, on the contrary, you get this reaction, continue to run in the urine from burette, drop by drop, and test until the reaction with the ferrocyanid shows no change in color. To calculate result, get total quantity of urine passed in twenty-four hours, expressed in cubic centimeters; divide this by the number of cubic centimeters run from the burette, and the quotient will be the amount of sugar excreted in twenty-four hours, expressed in grams.

Composition of Fehling's Solution.

Cupric sulphate,	34.64	gm.
Sodium and potassium tartrate,	173	"
Sodium hydrate,	60	"
Distilled water,	to 1000	c.c.

Ten c.c. of this solution is reduced by 0.05 gram of sugar.

CHAPTER V.

COLORING-MATTERS.

Abnormal coloring-matters appear at times in the urine, but, with the single exception of the coloring derived from blood, do not indicate any special form of kidney or urinary disease.

Bile, when found in the urine, indicates hepatic and portal congestions, and gives to it a brown or greenish-yellow color. Biliary acids with **leucin** and **tryrosin** indicate organic disease of the liver, generally acute yellow atrophy. Bile is detected in the following manner: To ten c.c. of urine is added three or four c.c. of a solution of caustic potash of exact composition—one part of potash to three of water; shake, and to the mixture add an excess of hydrochloric acid; if bile be present, the urine assumes a beautiful emerald-green color.

Rosenbach's Test for Bile.—A few cubic centimeters of pure nitric acid to which one drop of a five per cent. solution of chromic acid is added, is carefully overlaid with urine by means of a pipette. At the point of contact a play of the following colors is seen; green; blue; violet; and reddish-yellow ring. Green, however, is the only positive reaction since blue and red may be produced by indican or urobilin. This test may also be applied to the filter-paper of the filtered bile urine, when a play of the same colors is seen.

Biliary acids are seldom found in any appreciable

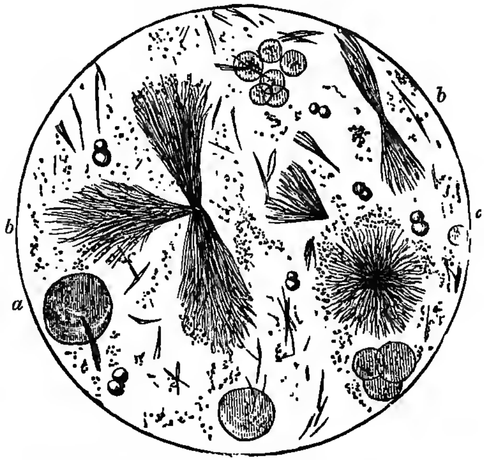

FIG. 8.—*a*, *a*. Leucin Balls. *b*, *b*. Tyrosin Sheaves. *c*. Double Balls of Ammonium Urate.

quantities, and as their detection is difficult and the pathologic processes which cause them to appear are the same as those causing the appearance of leucin and tyrosin, I will mention the tests for these latter only. Fifty c.c. of urine is taken and evaporated to a small bulk; if leucin and tyrosin are present, they will crystallize out, and may be examined under the microscope, leucin appearing as oily, circular discs floating on the water, and tyrosin as long, prismatic needles; should the urine contain albumin, it must be first rid of this by using as the precipitant a solution of lead acetate, which, again, must be eliminated by passing sulphuretted hydrogen through it, and the filtrate finally from the lead sulphid thus formed is used for evaporation.

BLOOD.

Blood appears in the urine under various pathologic conditions of the system, but from a clinical chemic standpoint we will consider but two conditions in which it constitutes disease of the urinary organs: First, when blood-globules or corpuscles are found; and secondly, when only the coloring-matter is present. The first condition is called hematuria and the second hematinuria. Blood may either come from the kidneys or else from the bladder, and to make a differential diagnosis we must consider the reaction, blood coagula, specific gravity, and microscopic appearance. Hemorrhage from the kidney is generally acid; from the bladder alkaline. When this alkalinity is due to the presence of carbonate of ammonia, it is then quite certain the hemorrhage was from the bladder. Dark brown or red-brown hemorrhages point to the kidneys as the diseased organs, whereas bright red would indicate the bladder; smoky, also, to dark brown urine points to lesions in the kidney. Soft clots, fresh and bright, are generally found in kidney hemorrhage, whereas hard, yellow, and sometimes colorless clots point to the bladder as the source of

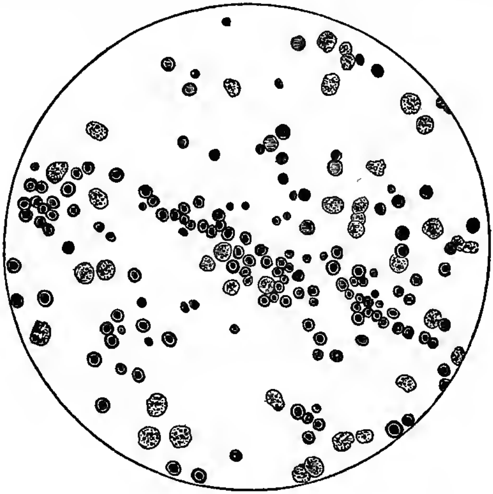

FIG. 9.—Colored and Colorless Blood-corpuscles of Various Forms.

trouble. Again, long and rod-shaped clots indicate hemorrhage from the kidney, whereas large and irregular masses are most probably from the bladder. In regard to the specific gravity, we generally find in kidney hemorrhage a condition of polyuria; in hemorrhage from the bladder, no polyuria.

Under the microscope, if the hemorrhage be from the kidney, we will find blood-tinged kidney epithelium, and if from the bladder epithelium corresponding to the same. For the special diseases causing this pathologic change in the urine the reader is referred to

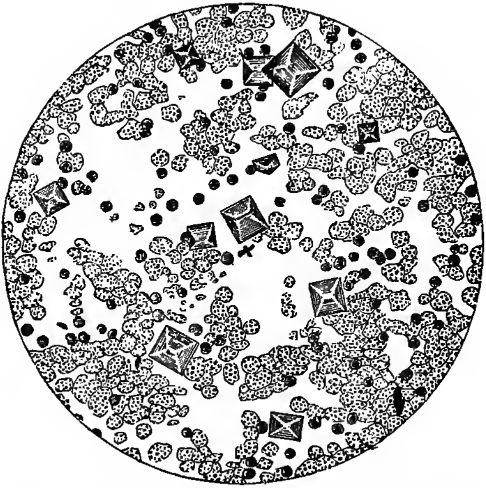

FIG. 10.—Shriveled Blood-corpuscles in Urine (Catarrh of the bladder) with Numerous Lymph-corpuscles and Caystals of Triple Phosphate.

special works on this subject, as the scope of this treatise does not permit of my so doing. The detection of blood in urine is determined either by aid of the microscope, by which we can identify the corpuscles, or else by the following chemic tests:

Guaiacum Test.—Mix one c.c. of freshly prepared tincture of guaiacum with the same quantity of old oil of turpentine or ozonized ether. Take two drams of the urine in a test-glass, and pour the guaiacum and turpentine upon the urine; if blood be present, between the resinous mass which precipitates out and the clear turpentine solution a tinge of blue

FIG. 11.—Hemin Crystals.

1. Human. 2. Seal. 3. Calf. 4. Pig. 5. Lamb. 6. Pike. 7. Rabbit.

will appear, depth of color depending upon quantity of blood present; shake up the mass and it will form a blue emulsion. Although this test will answer in the majority of cases, it is always well to strengthen it with the one I will now give, which is scientifically accurate but a little more troublesome to execute.

Hemin Test.—When corpuscles are not found in the urine, but simply coloring-matter, apply this test: Take three drams of the red urine, boil with a concentrated solution of caustic potash, and take the phosphatic precipitate which comes down with the blood-coloring matter (tinged red); dry, and mix with a few grains of pure chlorid of sodium;

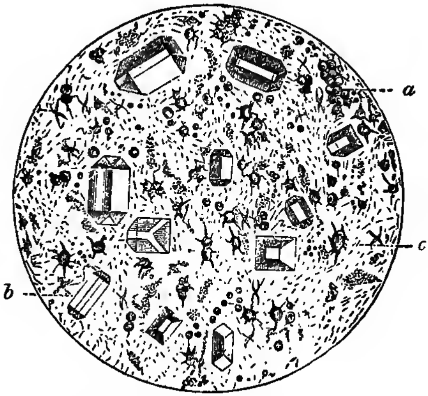

FIG. 12.—Deposit in Ammoniacal Urine (Alkaline Fermentation).
a. Acid Ammonium Urate. *b.* Ammonio-magnesium Phosphate.
c. Bacterium Ureæ.

place on watch-glass, add to it one or two drops of *glacial* acetic acid, placing in the mixture a strand of hair; after some time hemin crystals crystallize out on the hair, and may be identified by means of a microscope.

PUS.

Pus in the urine is *always* the sign of inflammation, either of the kidneys or else of the bladder and urinary tract. Urines containing pus are generally alkaline and if recently passed and of high specific gravity and alkaline may be justly considered as evidencing inflammation of the bladder; when, on the other hand, pus is found in an acid urine *recently* passed and of low specific gravity, it is an indication that the inflammation is either of the kidneys or else of the ureters. Albumin is also found in these cases, but in small quantity. Again, if the pus is from disease of the bladder, the specific gravity of the urine is normal or else a little above normal. Urines containing pus in large quantities are thick, stringy, and contain much sediment; the sediment may be composed of pus alone, or else of urates, epithelium, pus, and blood-globules. To differentiate these conditions, apply tests already given for blood, urates, and uric acid; examine epithelium deposit under microscope and apply following special test for pus: To the sediment add a solid piece of caustic soda or caustic potash; it will lose its color and gradually become a stringy, vitreous, and cohesive lump if the pus is in large quantity; in small quantities, however, the mass dissolves up, and leaves a fluid which is only stringy and vitreous.

Urobilin.—Urobilin is best detected when in urine by treating, say five c.c., with ammonia hydrate, when, if in large quantity, the fluid assumes a greenish hue. The phosphates are now filtered from the urine, and to the filtrate is added a solution of chlorid of zinc, which, if urobilin be present, brings out a rose-red color with a greenish iridescence.

Clinical Significance.—Urobilin is the chief coloring agent of normal urine, and exists in it in small quantity. It is increased in quantity, however, in acute septic fevers, to wit: pyemia, pneumonia, and typhoid fever, etc.; it is, on the other hand, diminished in all hydremic conditions of the blood, most notably in chlorosis, anemia, and hysteria.

Indican.—Indican is found in normal urine in *mere traces*, and when in larger amounts is abnormal, and, by some, considered as an evidence of disease of the pancreas.

Its presence is detected by adding to five c.c. of clear urine five c.c. of strong c. p. hydrochloric acid, to which three drops *only* of a solution of chlorinated soda have been added. The fluid, on this addition, if indican be present, changes to a more or less dark color, depth of tint being in proportion to the quantity of indican present. To make more sure, however, agitate the fluid with a little chloroform, which dissolves out the indigo formed by the above reaction and settles as a blue layer at the bottom of the liquid.

Acetone.—Acetone occurs sometimes in normal urine in traces, but when in large amounts is abnormal, and constitutes a condition better known as *acetonuria.* Its presence is detected as follows: Five c.c. of clear urine is treated with a few drops of a freshly prepared solution of the nitroprussid of sodium (strength 1:30). Strong ammonia is then added, and in a few minutes, if acetone be present, a red color is produced, which, on the addition of acetic acid, changes to a purple or violet color. If more accuracy is required, the urine must be distilled and the distillate treated as just described.

Clinical Significance.—Acetone frequently occurs in the urine in pronounced quantity in high fevers; also when a highly nitrogenous diet is indulged in, and toward the end of diabetes mellius.

Peptone.—Peptone does not occur in normal urine, and its presence by some is considered to be due to the disintegration of pus-corpuscles somewhere in the body. It is found in the urine in many acute and specific fevers—in cerebrospinal meningitis for instance—and may at times indicate whether a pleuritic effusion is purulent or not. Its presence in urine is detected as follows: If the urine contains albumin, this must first be precipitated out by acetic acid and ferrocyanid of potassium, and to the filtrate must be added a solution of phosphotungstic acid; on so doing a cloudiness appears immediately or after a while, depending on the amount of peptone present. To urine not containing albumin but having much color, a solution of the acetate of lead is first added; filtration is then effected, and to the colorless filtrate, which is now made acid by acetic acid, the phosphotungstic acid is added.

Ehrlich's Diazo Reaction in Typhoid Fever.—Although the Widal method of examining blood in typhoid fever has recently somewhat eclipsed Ehrlich's test, it is well to know how to apply it, since in the experience of the writer it has on many occasions given him most trustworthy results. The reaction depends upon the fact that sulphanilic acid in the presence of nitrous acid (HNO_2) forms diazosulphobenzol, which, uniting with certain aromatic substances occasionally present in urine, forms anilin colors.

The process requires two solutions, and is conducted as follows:

Solution I.—Two grams of sulphanilic acid, fifty c.c. of strong c. p. hydrochloric acid, and 1000 c.c. of distilled water.

Solution II.—One gram of sodium nitrite to 200 c.c. of distilled water.

In performing the test, fifty c.c. of Solution I is mixed with one c.c. of Solution II, and of this twenty c.c. is taken, placed in a test-tube, and to it added twenty c.c. of *clear* urine. Ammonium hydrate is now added until strongly ammoniacal, and if the reaction be positive, the solution assumes a beautiful carmin-red, which, on shaking, must also *appear* and *stay* in the foam.

To understand its clinical significance, and the claims set forth by its author, I quote as follows from Ehrlich:

"1. The reaction is most commonly found in typhoid fever from the fourth to the seventh day, and thereafter, and if the reaction be absent, the diagnosis is doubtful.

"2. Cases of typhoid fever characterized by faint reaction, and occurring only for a short time, may be predicted to be of very mild type.

"3. The reaction is occasionally noted in phthisis pulmonalis, but only in cases pursuing a rapid course toward a fatal termination.

"4. The reaction is sometimes, but not often, observed in cases of measles, miliary tuberculosis, pyemia, scarlet fever, and erysipelas.

"5. In diseases unaccompanied by fever, as chlorosis, hydremia, diabetes, diseases of the brain, spinal cord, liver, and kidneys, the reaction is always absent."

CHAPTER VI.

MORBID PRODUCTS WHICH ARE PROPERLY CLASSIFIED AS URINARY SEDIMENTS AND URINARY CALCULI.

URINARY SEDIMENTS.

Organized and unorganized sediments are found in the urine; the former, when present, constitute disease, the latter only when in abnormal amounts. Tube-casts, blood-corpuscles, epithelium cells, and spermatozoids are organized; uric acid, urates, phosphates, and oxalates, unorganized. Uric acid is generally in lozenge-shaped crystals, urates indistinctly crystalline, phosphates generally in distinct prismatic crystals, and oxalates in small octahedra or dumbbells.

Urinary calculi are usually composed of either uric acid and urates of sodium, potassium, and calcium, or else of phosphates and oxalates of calcium; xanthin and cystin are only occasionally found. To test these calculi, pulverize, place a small portion on platinum foil, and heat over the Bunsen flame.

1. If no residue is left, it is either uric acid, am-

monium urate, xanthin, or cystin. To determine this, take a small portion, place on watch-glass, add a few drops of dilute nitric acid, and heat to dryness; add to this a few drops of ammonia, and if mass changes to beautiful purple color (murexid test), sediment is either uric acid or urate of ammonia; if no change of color, the substance is xanthin or cystin. To determine this, take the portion of original pulverized calculus, and dissolve in nitric acid on

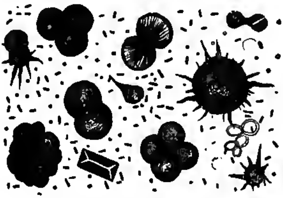

FIG. 13.—Acid Ammonium Urate Crystals.

watch-glass; if solution turns yellow on evaporation, and leaves a residue insoluble in potassium carbonate, the calculus is xanthin; should the solution, however, turn brown, and leave a residue soluble in ammonia, it is cystin.

2. If on heating the pulverized calculus on platinum foil a residue is left, the calculus is either a urate of calcium, or else an oxalate or phosphate of the same. To determine this, dissolve the substance in hydrochloric acid (on a watch-glass); if it effervesces, the

calculus is either a urate or oxalate. If the murexid test gives a negative result, why then it is an oxalate. If on adding hydrochloric acid solution is attained without effervescence, the calculus is a phosphate, which may be further verified by adding to the solu-

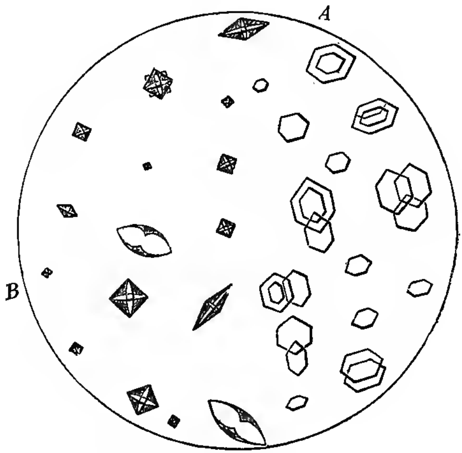

FIG. 14.—*A*. Crystals of Cystin. *B*. Oxalate of Lime Crystals.

tion a few drops of nitric acid solution of molybdate of ammonia, when a canary-yellow precipitate immediately forms.

Calculi, when occurring in the urine, although indicating no direct disease of the kidneys and urinary apparatus, do indicate, by the particular kind, the special diathesis which is being established in the system, and which, in due course of time, will eventuate in disease of the urinary organs. Sediments,

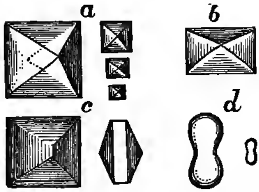

FIG. 15.—Oxlate of Lime Crystals.
a, *b*. Octahedra. *c*. Compound Forms. *d*. Dumb-bells.

too, which precipitate out immediately or a short time after voiding the urine indicate a strong tendency to the formation of concretions.

CHAPTER VII.

DIFFERENTIAL DIAGNOSIS OF CHRONIC BRIGHT'S DISEASE, BASED ON A CLASSIFICATION OF THE NORMAL ABSOLUTE, THE ABSOLUTE, AND THE RELATIVE ABSOLUTE OF SOLIDS AND UREA FOUND IN URINE WITH ALBUMIN AND WITH OR WITHOUT TUBE-CASTS.

In using the term chronic Bright's disease instead of chronic nephritis, I know I yield to a popular, but at the same time, I must say, most generally well-understood condition of the patient, if not of his organ affected.

It is quite true that the cases described by Richard Bright in 1827 are not those seen by us to-day under the title of chronic, but rather belong to the acute form of the malady, which, in our experience, is usually a self-limited disease, and will run its course and leave the patient generally without damage, provided it has been properly cared for. By chronic Bright's disease, therefore, I wish to indicate a far more formidable malady—a disease which at times comes on most stealthily, and after making certain headway is beyond cure. I include, then, under and in this category the large white kidney, the small granular kidney, the small granular and fatty kidney, and, finally, the amyloid or waxy kidney.

Tube-casts.—Tube-casts are considered to be fibrinous molds of the kidney tubules, and they frequently are mixed with blood- or pus-corpuscles, granular matter, epithelial cells, various crystals, and oil drops. When mixed with the epithelial cells, they are called epithelial casts; when containing

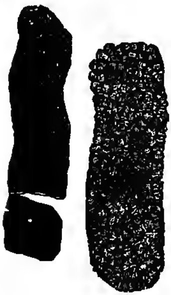

FIG. 16.—Coarsely Granular Casts.

FIG. 17.—Acid Sodic Urate in Cylinders.

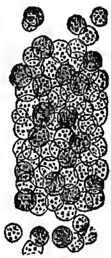

FIG. 18.—Leukocyte Cast.

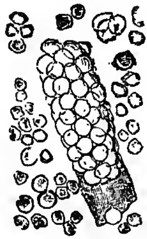

FIG. 19.—Blood-Cast.

oil drops, fatty casts, or oil casts, and when appearing as perfectly clear and transparent cylinders, having the same refractive power as urine,. they are termed hyaline casts.

Blood-casts, as their name implies, contain blood-corpuscles, and are indicative of acute inflammation of the kidneys.

Granular casts are those containing granules, large or small, and are composed of granular matter coming either from the breaking-up of the epithelial

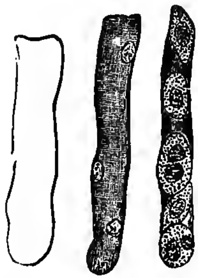

FIG. 20.—Hyaline Casts.

FIG. 21.—Epithelial Cast.

FIG. 22.—Finely Granular Cast.

FIG. 23.—Peculiar Changes of the Red Blood-corpuscles in Hematuria.

cells and blood-cells, or else from the material of which the cast itself is composed. When of the dense and coarsely granular type, they are very indicative of chronic interstitial disease.

Mucous casts are frequently mistaken for regular tube-casts, but the *absence of albumin*, together with the other conditions of the urine to be elaborated, will render a mistake in diagnosis in these cases highly reprehensible. Hyaline casts, too, even in urine

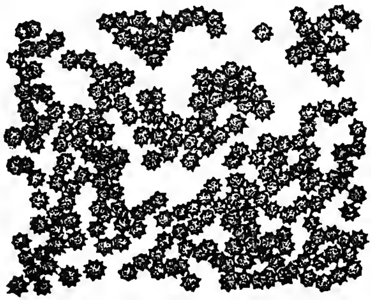

FIG. 24.—Crenated Red Blood-corpuscles in Renal Hematuria.

without albumin, are *not rare* in the experience of the author; but the other guides to diagnosis, soon to be given, will prevent mistaking these kind of cases for true Bright's disease.

Finally, **cast-like formations of the urates** may be mistaken for granular casts, as they bear some close resemblances to the same; the *rounded ends* of the real tube-casts, however, will avoid such a mistake, which *very distinctive feature is not found* in these false casts.

Cases Classified According to the Absolute, the Normal Absolute, and the Relative Absolute.—By absolute we mean the total quantity of solids

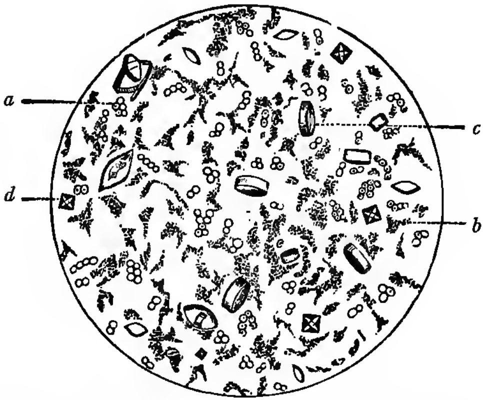

FIG. 25. Deposits in Acid Fermentation of Urine.
a. Fungus. *b* Amorphous Sodium Urate. *c*. Uric Acid.
d. Calcium Oxalate.

and urea found in any urine, irrespective of the quantity passed.

By normal absolute we mean the total quantity of solids and urea as contained in a normal elimination of urine of twenty-four hours. It is, therefore, the same, or nearly so, as the relative absolute. Finally, by the relative absolute we mean the amount of solids and urea as compared with the normal absolute.

In health the normal absolute of solids varies from 60 to 70 grams, and urea 30 to 35 grams; the quantity of water passed also in winter varies from 1200 c.c. to 2000 c.c., and in summer from 900 c.c. to 1500 c.c.; the specific gravity, too, according to this variation in quantity of urine passed, shows a range in winter of from 1.013 to 1.022, and in summer of from 1.017 to 1.030. If, however, a urine containing no albumin and no sugar shows an increase of the absolute, it is an evidence of a condition of baruria, generally due to excessive elimination of phosphates or else urea. To make certain, therefore, which it is, make an estimation of the absolute urea, and note its quantity; if this be normal, then the increase in solids is, no doubt, due to phosphates; should sugar be also present, the estimation of its quantity, or else of that of the phosphates, will give the information desired.

The absolute *without the presence of albumin* is increased in conditions of the system attended with great loss of flesh, and is technically called baruria. The normal absolute, again, remains constant, or increases with corresponding increase of relative absolute, in all conditions of congestion of the kidneys; this condition of things is markedly shown in heart disease, where, too, albumin and tube-casts frequently occur. To differentiate, then, this from chronic Bright's disease is sometimes very difficult; the history, however, of the case previous to the heart lesion, together with the gradual lessening of the urine and increase of solids and urea, will tend to exclude chronic Bright's disease, which, in the experience of the author, has never given such a clinical picture of the urine.

Classification of Cases.—

I. Absolute solids, 60 to 70 grams; with relative absolute, 60 to 70 grams—of which urea is found to be 30 to 35 grams, with relative absolute, 30 to 35 grams; *no albumin*, *no sugar*, and *no tube-casts*—constitutes an absolutely healthy condition of the kidneys.

II. Absolute and relative solids, sixty grams or more, of which urea is found to be twenty grams or less, *with albumin*, and, in those nearing middle life, attended or *not* with appearances of tube-casts of only, say, the hyaline type, *is* a sign of chronic Bright's disease. To this class belong the *so-called functional albuminurias* in young people, not commonly met with after twenty years of age, but most frequently encountered about the age of puberty. In these cases, too, the absolute and relative absolute of urea is found generally to run twenty or more grams instead of less.

III. Absolute and relative absolute solids, sixty grams or less, of which urea is found to be twenty grams or less, points strongly to some disorganization of the liver, *provided no albumin* is found.

As a specimen of this kind of urine I append the following analyses of a case which, on October 1, 1898, showed only 9.75 grams of urea, and after treatment for a month and over showed as follows:

Analysis made October 26, 1898.	
Quantity of urine passed in twenty-four hours,....................	1450 c.c.
Specific gravity,.................	1.014
Reaction,......................	Acid.
Albumin,......................	None.
Sugar,.........................	"
Absolute solids,................	48.49 gm.
Absolute urea,.................	17.40 "
Second analysis, made November 14, 1898.	
Urine passed in twenty-four hours,.	1150 c.c.
Reaction,......................	Acid.
Specific gravity,.................	1.021
Albumin,......................	None.
Sugar,.........................	"
Absolute solids,.................	56.26 gm.
Absolute urea,..................	21.22 "

As the patient is under treatment, there is no benefit derived from making a calculation as to the relative absolutes, which gives us only the physiologic action of the kidneys when they are under no stimulation save that of the weather.

IV. Absolute solids, forty grams or less, of which urea is found to be twenty grams or less, *without albumin*, is no sign of chronic Bright's disease, but simply an evidence, generally, of some neurasthenic condition in which the solids carried to the kidneys for excretion are below the normal, and *not* that the eliminative capacity of the kidney is in any wise affected; these cases have been described by Sir Andrew Clark as cases of "renal inadequacy," but which, in the author's experience, seem due to the cause above mentioned.

In the author's experience, when the kidneys are really damaged, these cases show a *slight* quantity of *albumin* in the urine, and also fail to respond *so readily* to a salt diet when instituted.

This test of the salt diet is applied in the following manner: The patient is given thirty or more grains of chlorid of sodium each day, preferably in the form of a tablet devised by the author for anemia and Bright's disease, and manufactured by Messrs. Parke, Davis & Co., of Detroit, Michigan, under the name of Salt and Iron Tablets. Three or four of these tablets are given each day, and afterward the urine examined daily, when, if it be a case not complicated with chronic kidney lesions, the urine immediately shows an improvement in the absolute solids excreted, and frequently in a greater relative than calculated, showing thus a more concentrated urine. These neurasthenic urines are generally great in quantity, but very low in specific gravity.

V. Absolute solids sixty grams or more, of which urea is found to be thirty or more, but in which the relative absolute solids are less than fifty grams, of which the urea is found to be less than twenty grams, with the *slightest* show of albumin, and with or without hyaline, granular, and epithelial casts, are, in my experience, an *unfailing* sign of chronic Bright's disease. The interstitial variety of kidney degeneration most commonly shows this kind of urine, and begins in this way, but at times it becomes hard to determine whether it belongs to this or rather to the chronic parenchymatous form; the appearance, however, of much and *general* edema, the greater quantity of albumin, and the comparative youth of the patient (between twenty-five and forty-five), would point to chronic parenchymatous degeneration rather than to interstitial growth and contraction. As a specimen of the urine under these conditions, I place the following, taken from my case-book, from a gentleman under my care now for several years, and for whom I at regular intervals carefully examine the urine:

Age of patient, fifty-four.
Analysis made January 6, 1897.

Quantity of urine passed in twenty-four hours,.........	3480 c.c.
Reaction,.....................	Slightly acid.
Specific gravity,..............	1.010.
Albumin,.....................	Considerable quantity.
Absolute solids,..............	81.08 gm.
" urea,..............	31.32 "
Relative absolute solids,......	46.60 "
" " urea,.......	17.99 "

In regard to the relative solids and urea, the calculation has been based on the passage of 2000 c.c. as being physiologic, which, at the time of the year the analysis was made, I consider an allowable maximum; cold weather and *easterly* winds laden with moisture having, in the experience of the author, sometimes on *healthy* kidneys far more diuretic effects than the strong drugs we frequently give for a like purpose in diseased conditions. Since the above analysis represents, in this class of interstitial cases, probably the best phase of the disease, I append another, which more nearly represents what the general practitioner will meet with in regular and uncomplicated cases:

Age of patient over fifty years.
Date of analysis, March 27, 1907.

Quantity of urine passed in twenty-four hours,	3240 c. c.
Reaction,	Slightly acid.
Specific gravity,	1.007.
Albumin,	Very slight amount.
Absolute solids,	52.84 gm.
" urea,	21.06 "
Relative absolute solids,	32.59 "
" " urea,	13.00 "

Having cited, now, two cases as specimens of the urine in male patients in the interstitial form of chronic Bright's disease, I take again from my case-book an interstitial renal affection occurring in the female, and in which the urine showed as follows:

Analysis made December 11, 1895.
Patient, woman fifty-five years of age.

Quantity of urine passed in twenty-four hours,	1560 c.c.
Reaction,	Slightly acid.
Specific gravity,	1.018.
Albumin,	Slight amount.
Absolute solids,	65.42 gm.
" urea,	23.40 "

As the quantity of solids in the urine passed here is a physiologic amount, no calculation as to the relative is necessary. The presence, however, of *albumin regularly* with this kind of urine, and after thirty years of age, in the experience of the author relegates the condition into one of renal degeneration, and very soon we note in these cases a change in the urine in which the solids and urea fall absolutely and relatively, or else the relative absolute solids and urea increase, thereby showing diminished excretion of water. As an evidence of this I will give two more examples of urine taken from this same patient, but will add that the patient *did not die* until *nearly three years and a half* had elapsed from the time at which the urine showed this *normal passage* of *solids and urea*. This is an *important fact to note*, since, in the experience of the author, the signals of an approaching end are to be seen by comparing the absolutes and relative absolutes.

Analysis made January 11, 1896.

Urine passed in twenty-four hours,	1470 c. c.
Reaction,	Slightly acid.

Albumin,	Considerable amount.
Specific gravity,	1.018.
Absolute solids,	61.65 gm.
" urea,	23.52 "

Without now giving a number of analyses showing a lessening of the absolutes which occurred, I will place for your attention one made six months before the patient died; it was as follows:

Analysis made October 27, 1897.

Quantity passed in twenty-four-hours,	1380 c.c.
Reaction,	Neutral.
Specific gravity,	1.009
Absolute solids,	27.26 gm.
" urea,	8.50 "
Relative absolute solids,	29.63 "
" " urea,	9.23 "

The relative absolute solids and urea have been calculated on a basis of 1500 c.c. as being physiologic at this time of the year in Charleston, S. C.; as it is usually warm, it being *only* during cold weather, and *particularly* when attended with *easterly* winds, that a maximum allowance to the amount of 2000 c.c. has seemed a proper gauge to consider within the range of health.

I have said that occasionally we find in this kind of kidney degeneration urine showing at times not even a trace of albumin when the tests are applied in the ordinary way; this, I think, is due to the extreme tenuity in which the albumin is held in solution.

If, then, in these *clear* urines you evaporate *below* the boiling-point until half their bulk, or until the solids just begin to show on account of the abstraction of water, then the same tests applied will not give negative results.

As urines of this description I append the following from a female patient who died of interstitial nephritis:

Analysis made November 17, 1896.

Urine passed in twenty-four hours,	2310 c.c.
Reaction,	Neutral.
Specific gravity,	1.004
Albumin,	Mere trace.
Absolute solids,	21.43 gm.
" urea,	4.62 "
Relative absolute solids,	18.55 "
" " urea,	4.00 "

Analysis made February 6, 1897, of urine from same patient:

Urine passed in twenty-four hours,	840 c.c.
Reaction,	Slightly acid.
Albumin,	None by tests applied in the usual way.
Specific gravity,	1.013
Absolute solids,	25.44 gm.
" urea,	9.24 "
Relative absolute solids,	60.56 "
" " urea,	22.00 "

As before said, when the analyses are made in cold weather, 2000 c.c. must be considered as physiologically permissible, but during the winter or fall, if the weather is warm and balmy, a general average of 1500 c.c. will be nearer right on which to base the calculation of relative solids and urea. Should the analyses be made in summer, in the experience of the writer a minimum of 900 c.c. or maximum of 1500 c.c. is permissible in health.

VI. Under this head we place those cases in which the absolute solids are thirty grams or less, and of which the urea is found to be ten grams or less, with relative absolute solids twenty grams or more and urea ten grams or more, with small or large show of albumin and with or without hyaline, granular, or epithelial casts. These are truly cases of chronic Bright's disease in their last stages, which may have been preceded by either the amyloid kidney, the large white kidney, the fatty kidney, or else the granular or contracted kidney. As an example of urine of this description I append the following analysis:

Analysis made October 27, 1897; patient, female.

Urine passed in twenty-four hours,	1380 c.c.
Reaction,	Neutral.
Specific gravity,	1.009
Albumin,	Small amount.
Absolute solids,	27.26 gm.
" urea,	8.50 "
Relative absolute solids,	29.63 "
" " urea,	9.23 "

The relative solids and urea are calculated on a basis of 1500 c.c., but really for diagnostic and prognostic purposes, when the urine shows so low an absolute amount of solids and urea as in the above analysis, it is unnecessary to calculate what it would be to a normal excretion of solids and urine respectively.

It may be, however, broadly stated that when the relative absolute solids and urea rise in the neighborhood of what the *normal absolute* ought to be, at the expense of the absolutes, then the case is very near to a close; thus, in the case already cited, at which the analysis was made a few months prior to death, it will be seen that the relative absolute solids were 60.56 grams and the relative absolute urea 22.0 grams, whereas the absolute solids were 25.44 and urea 9.24 grams.

I now append the result of my analyses of a few more specimens of urine taken from patients still alive, and some of whom have passed away, to show how *long* persons can live with interstitial degeneration of the kidneys, *even* when the solids and urea, absolutely and relatively, the one or the other, are high or low.

Case I.—Patient, male; age about fifty, still alive, and apparently enjoying good health.

Analysis made April 24, 1895.

Urine passed in twenty-four hours,	3250 c.c.
Reaction,	Acid.
Specific gravity,	1.006
Albumin,	Very slight amount.
Absolute solids,	45.43 gm.
" urea,	20.15 "
Relative absolute solids,	20.96 "
" " urea,	9.60 "

The relatives have been calculated on a basis of 1500 c.c. of urine as normal for this time of the year. It may be said of this patient that he has regularly taken my salt and iron tablets, and this analysis only represents, then, his condition before he began treatment.

Case II.—Patient, female.

Analyses made November 21, 1894, December 1, 1894, December 6, 1894, December 18, 1894.

Analysis of November 21, 1894.

Urine passed in twenty-four hours,	2240 c.c.
Reaction,	Alkaline.
Specific gravity,	1.005
Albumin,	Little.
Absolute solids,	26.09 gm.
" urea,	6.72 "
Relative absolute solids,	23.29 "
" " urea,	6.00 "

Analysis of December 1, 1894.

Urine passed in twenty-four hours,	2160 c.c.
Reaction,	Alkaline.
Specific gravity,	1.005
Albumin,	Little.
Absolute solids,	25.16 gm.
" urea,	7.53 "

Analysis of December 6, 1894.

Urine passed in twenty-four hours,	1320 c.c.
Reaction,	Acid.
Specific gravity,	1.010
Albumin,	*Very* little.
Absolute solids,	30.75 gm.
" urea,	7.92 "

Analysis of December 18, 1894.

Urine passed in twenty-four hours,	1500 c.c.
Reaction, ...	Slightly acid.
Specific gravity, ...	1.012
Absolute solids, ...	41.94 gm.
" urea, ...	11.10 "

This patient died in the spring of 1898, showing at that time, and six months before, an increase of the relative absolute of solids and urea at the expense of the absolute, thus evidencing extreme dilatation of the heart. In summarizing, then, the lessons to be taught by these analyses, and many more I could give, I will say a few words about tube-casts, since it will be observed that I do not state in these analyses whether or not I found them. This I have purposely done, as I have for a long while contended that it was, in the vast bulk of cases, *entirely* unnecessary to look for them when other clinical features were present in the urine, and which, when found, were far less misleading than the occasional finding, say, of hyaline, and at times even granular, tube-casts in the urine of one past middle age, and in other respects in good health.

What, then, are the clinical features that make tube-casts not misleading, and upon which we rely in making a differential diagnosis of chronic renal affections? My answer is: First, the presence of *albumin* in the urine; second, a diminution in the relative absolute solids and urea, with a normal quantity of solids and urea (*not* normal absolute, which refers also to normal quantity of urine) or an excessive amount of absolute solids and urea; third, an increase in the relative absolute solids and urea at the expense of the absolute.

If, with these conditions, tube-casts are found, they make us doubly sure of our diagnosis, whereas their absence would not with us exclude chronic Bright's disease.

In our observations tube-casts are not found to any extent, unless in urine in which the above conditions have been fulfilled; and when they are occasionally seen in urine which does not react as just set forth, we think chronic renal lesions may be excluded.

Tube-casts have generally been divided into the hyaline—broad and slender—the granular, and the epithelial; frequently, we meet with one and sometimes with all in chronic Bright's disease, and were it thus only in these affections that they are met with, why then we would have a sure means of diagnosticating Bright's disease; as this is not the case, however, we must fortify their finding with the other clinical features already elaborated, and which, in the experience of the writer, has failed less often than when tube-casts, and *especially* of the hyaline type, were taken as evincing a disease of the kidney.

Finally, there are certain fevers—and if our knowledge were greater, I feel sure the list would be much enlarged—which are attended at their commencing stages with symptoms which, by the novice, might be taken for acute, but hardly for chronic, Bright's disease—to wit: an appearance of albumin and tube-casts. As far, however, as my experience goes with this class of cases, I am not aware that the other clinical features of the urine already stated are met with *unless* a chronic affection is coincident with the fever. As the fever advances, the clinical features of the urine are so changed that he would be a bold —yes, rash—diagnostician, who would venture an opinion as to the real state of the kidneys; at the *beginning* of the attack, or else when convalescence is *well established*, should be the time to definitely determine if the kidneys are really diseased.

The infective diseases are those in which these changes of the urine are observed, and most markedly in the author's experience in pneumonia, typhoid fever, diphtheria, and scarlet fever; that it occurs in some others is equally true, as some of the recent text-books used in our medical colleges will show.

The author would also add that during the paroxysms of malarial fever albumin is frequently found in the urine, together with tube-casts and blood-corpuscles. If the paroxysms are not quickly relieved by proper medication, the albumin continues in the urine for some length of time, even after the patient is up and about. This malarial poison is, therefore, in my experience, a prolific cause for degeneration of the kidney when allowed to remain in the system; and though during an attack of malarial fever one may expect frequently to meet with cases showing albumin and tube-casts in the urine, after the fever is over, if the kidneys are not damaged, these abnormal products should vanish.

In health the normal and relative absolutes of solids should be either the same or range between sixty and seventy grams. In disease, however, they vary much; as a means, then, for comparing these variations I append the following tables, and will designate them *a*, *b*, *c*, respectively, dividing these also into four stages.

The estimation of relative absolute is calculated from the total solids or total urea as compared to a normal passage of urine in 24 hours: thus, patient passed in 24 hours 3000 c.c. with a total passage of 30 grams of solids. What is the relative absolute?

3000 c.c. : 30 grams : : 1500 c.c. : R. A.
which thus is 15 grams.

(*a*) In Health without Albumin.

Solids.	N. A. 60 to 70 gm.	a	R. A. 60 to 70 gm.
Urea.	N. A. 30 to 35 gm.		R. A. 30 to 35 gm.

(*b*) IN DISEASE AND WITH ALBUMIN.

Solids.	A. 60 gm. or more.	R. A. 50 gm. or less.
	A. 50 " "	R. A. 40 " "
	A. 40 " "	R. A. 30 " "
	A. 30 " "	R. A. 20 " "
	or else	
Solids.	A. 40 gm. or less.	R. A. 60 gm. or more.
	A. 30 " "	R. A. 45 " "
	A. 20 " "	R. A. 30 " "
	A. 10 " "	R. A. 20 " "

(*c*) IN DISEASE AND WITH ALBUMIN.

Urea.	A. 30 gm. or more.	R. A. 20 gm. or less.
	A. 20 " "	R. A. 15 " "
	A. 15 " "	R. A. 10 " "
	A. 10 " "	R. A. 5 " "
	or else	
Urea.	A. 20 gm or less.	R. A. 30 gm. or more.
	A 15 " "	R. A. 20 " "
	A. 10 " "	R. A. 15 " "
	A. 5 " "	R. A. 7 " "

A., the absolute; N. A., the normal absolute; R. A., the relative absolute.

On comparing these tables, then, it will be seen that the absolute decreases and the relative *increases with albumin*, with or without tube-casts, in the final months of chronic Bright's disease; and that the absolute increases and the relative absolute decreases in the commencing stages of chronic Bright's disease, and generally continues to do so, or may, by proper treatment, be made to do so, until the stage of dilatation of the heart is established.

In the experience of the author a urine which, under strong stimulation of the kidneys, shows of absolute solids thirty grams or less, and relative absolute forty-five grams or *more*, is an evidence of the utter hopelessness of the case; so long as the relative absolute can be made to descend and the absolute to ascend, we should not despair; but so soon as the reverse is actually established, why then all treatment is of no avail, and the end must and will come.

Finally, the inference drawn from the above tables may be succinctly stated as follows: In urine containing albumin:

1. The absolute nearly what the normal absolute would be.

2. The absolute increased and the relative absolute decreased.

3. The absolute decreased and the relative absolute increased.

No. 1 represents the starting stage of chronic kidney lesions, and generally the so-called functional albuminurias begin in this way; *occasionally*, however, even in advanced cases, by *strong* stimulation the kidneys may for a time show this kind of urine, but they very soon lapse into the third stage, and after so doing run the regular course, showing diminution of solids absolutely and increase relatively.

No. 2 represents what is seen in the advancing stages of kidney lesions, and may extend over many years.

No. 3 is sometimes the natural consequence of what has preceded in No. 2, and brings us nearer the end of the disease.

Inasmuch, then, as the determination of the normal absolute and relative absolute is, with us, of such importance for making a correct diagnosis, as well as prognosis, I will now say a few words as to the taking of the quantity and specific gravity of the urine:

I. No urine should be collected from any person who is undergoing any treatment whatsoever.

II. If such be the case, treatment should be intermitted until a few days have allowed the medicines to pass from out of the urine.

III. The individual should only be allowed as a drinking beverage rain, well, or spring water, so that the excreting capacity of the kidneys may be physiologically gauged: an allowance each day, in winter, of not less than three tumblerfuls if soup is not taken, or two if it is; and in summer, under the same conditions, of not less than six; or four will be sufficient with a good ordinary average diet of food *not* excluding tea or coffee—one or the other at breakfast and at night, if that has been the custom of the individual whose urine you are examining. Although these quantities represent, in our experience, a good average in adults of sedentary habits, they would have to be increased if the person indulged in exercise just before the examination.

IV. And, lastly, the specific gravity should be taken and solids calculated on the basis of 60° F.; and for every $5.\dot{5}^\circ$ increase in temperature of the urine above that, an addition of one degree must be made to the reading. Thus, if the patient passed a urine of specific gravity 1.016, temperature 80°, it would read 1.0196.

Before concluding, I deem it well to say a few words in regard to neurasthenia in persons suffering from chronic Bright's disease. When this condition is coincident with kidney lesions it makes a prognosis at times very difficult, and it is only by *repeated* examinations of the urine that this source of error can be eliminated. For example, we have seen in an interstitial nephritis an average analysis of the urine show 68.50 grams of absolute solids and 27.93 grams of absolute urea, and during a nervous condition we have seen the same urine show less than forty grams of absolute solids with less than fifteen grams of urea. Most assuredly, then, a prognosis based on this latter analysis would be misleading, and would lead us into giving too grave a prognosis as to the immediate future of the patient. A *continuous* neurasthenic affection, whether or not induced by the kidney lesion, is, in our experience, a grave complication, and will much shorten the life of the individual; but a transient and occasional array of neurasthenic symptoms does not portend so seriously.

Finally, as life insurance is getting to be a matter of great importance and everyday occurrence, I shall conclude this chapter by giving the following rules, which, it is thought, will aid the examiner in avoiding bad risks and accepting those which, by the author, seem legitimate ones:

Rules for Life Insurance Examiners.

Rule I.—View with suspicion any specimen of urine containing albumin, and be especially cautious if the specimen at the same time during the winter months shows a winter minimum of 1.013 specific gravity, or else during the summer the minimum of 1.017.

Rule II.—Reject any urine after middle age containing albumin with the absolute solids and urea either normal or else increased and the relative absolutes decreased.

Rule III.—Reject a urine showing albumin and a decrease of absolutes with an increase of relative absolutes.

Rule IV.—Do not regard after middle age the occasional finding of tube-casts, hyaline and sometimes granular, as militating against insurance *if the absolutes and relative absolutes are normal and the urine is also free from albumin.*

Rule V.—Never report a urine free of albumin in which the absolutes and relative absolutes appear as in Rules II and III, unless you have evaporated the urine below boiling to a point at which the solids begin to precipitate out, and to which condensed urine you have applied the tests for albumin.

The view, then, held by us as to the value to be attached to the finding of tube-casts in the urine, although opposed to that usually taught, is based upon the experience of the author, extending over several years, with cases most carefully watched. He is aware, therefore, that he may encounter much opposition from the profession in accepting his experience as a guide for safety, and especially from examiners of life insurance companies, who pay, we think, far too much attention to the finding of tube-casts in those past middle age, and *too little* to the other clinical features which we have tried to clearly set forth as far more certain guides. We feel, then, that tube-casts after middle life are often but the expression of natural, and not of serious, pathologic changes going on in the kidneys, together, we believe, with similar changes in other organs, with the *exfoliations* of which science at present is not sufficiently familiar. We are led to this conclusion from the following facts:

First, that kind of kidney lesion attended with a large show of tube-casts is curable, or, rather, self-limited, and generally leaves the kidney uninjured. I refer to acute Bright's disease. Surely, here the epithelial lining of the tubules is replaced, or else the kidney would not do its work as before the attack, which factor—*its capability* of doing its *former work*—is the *only true gauge* to judge a kidney by.

Second, that kidney lesion which is far beyond cure, but which sometimes extends over many years, is frequently attended with but few tube-casts. In this kidney degeneration surely the exfoliation of a few tube-casts can not be looked upon as of so serious import, or as the cause of the final changes found in this kidney. It will also be noted that their presence gives us no data by which to formulate a prognosis.

This change in the cirrhotic kidney and epithelial lining of the tubules appears to us to be more in the way of crowding out by the condensation of kidney tissue into connective-tissue substance. The most fatal and short-lived form of kidney lesion in my experience has been the large white kidney. Here the epithelial lining is not only inflamed and exfoliated in large masses, but the entire kidney is in a state of subacute inflammation and congestion. These two processes, therefore, working together, if not relieved, most absolutely change the excreting capacity of the kidney. So we have increased exudation of albumin from the continued pressure and hydremic condition of the blood, and also the copious appearance of tube-casts, due to inflammation not only of a chronic character, but at times of a subacute and even acute form, attended with fever.

This acute exacerbation grafted on a chronic kidney lesion is far more often, in my experience, met with in the large white kidney than in the true cirrhotic; that it may occur in this form of kidney lesion is no doubt true, but of its general occurrence we think less likely. With us, too, the large white kidney has always been far more sensitive to atmospheric changes and gastric disturbances than the cirrhotic. The possibility, however, of conducting by judicious treatment the large white kidney into the secondary and finally atrophic form is always to be kept in mind, for in so doing life may be prolonged and a miserable and distressing train of symptoms relieved.

Third, and lastly, the exfoliation of kidney tissue in the form of tube-casts is now by some admitted to *frequently* take place when toxins occur in the blood, and *which*, when eliminated, leave the kidney *unhurt*.

With these reasons, then, for taking this view in regard to tube-casts, I conclude this chapter.

CHAPTER VIII.

RESUME.

THE DIAGNOSIS OF DISEASES OF THE KIDNEY AND URINARY ORGANS.

All forms of kidney degeneration are due to one of three causes:

1. Hyperemia, which, when active, is called acute congestion, and when passive, chronic congestion.

2. Irritation; this is almost always active in its character, and sooner or later eventuates in inflammation, or else, taking a more chronic or subacute course, brings about those pathologic changes which are termed capillary arterio-fibrosis.

3. Inflammation; this, too, is either of an acute and active form, or else of a more chronic and subacute character. The causes or class of causes which bring about this condition of things are either direct or indirect, the first class inducing active inflammation and the second an inflammation of a more chronic course.

To differentiate these several phases of kidney disease requires, at times, a good deal of well-directed patience and perseverance. Important is it, however, for on the right appreciation of the case not only depends a proper prognosis, but at times the very life of the patient itself.

Hyperemia, whether active or passive, is not in itself a disease of the kidneys, but simply the expression of a condition which, if unrelieved, will eventuate in disease. The appearance of and morbid anatomy of the kidneys undergoing this process are important to us only as a pathologic study for future information. The appearance and character of the urine passed during this period, on the other hand, are of great practical use and importance, as they can be gathered during life, whereas the pathologic study begins only when life is extinct. The differential diagnosis between active and passive congestion is made as follows:

In active congestion we have a complaint coming on suddenly; in passive, coming on gradually. In active congestion the arterial system is in a high state of tension; in passive, the tension is low. In active congestion the urine is suddenly decreased in quantity or else normal, specific gravity normal, and little or no albumin; in passive, the urine will be observed to have decreased from day to day, to contain more albumin, to have increased in specific gravity and depth of color, and to have, on standing, a decided sediment of the salts which precipitate out from the diminished volume of water. If this condition be allowed to continue very long, albumin increases to great quantities in the urine, and with the increase the patient becomes anasarcous; if the cause of the venous stasis can not be removed, the case rapidly goes into nephritis of a chronic character. The *time* at which this change takes place is *always* marked by a *decrease* of *specific gravity* (under 1.018), and the appearance, generally, of granular and tube-casts. Should active hyperemia run on uncontrolled, the case is more apt to develop into one of acute nephritis.

The direct causes of active hyperemia are usually sudden variations between the surface and central temperatures of the body, brought about by chilling the body in various ways.

Passive hyperemia, or renal stasis, is due to obstructive causes—such as occur in heart, lung, and liver diseases—chronic peritonitis with effusion, hydatid tumors, pregnancy, and, in fine, to all sources which obstruct the direct, or else the return, blood-supply of the kidneys. In both forms of hyperemia the temperature of the body is not increased unless some intercurrent affection is also present. I may finally add that, as a further means of diagnosing these two conditions, the effect of diuretics and arterial tonics and sedatives may be made use of.

In active congestion diuretics and arterial tonics which owe their diuretic action to an increase of the tension of the blood are *pernicious*, whereas sedatives or diuretics which increase the flow of urine by simply increasing the transudation of water are *beneficial.* In passive congestion, digitalis, spartein, and caffein act with efficiency and promptness, and lose only their effect when the obstruction which causes the stasis is permanent and increasing.

PARENCHYMATOUS NEPHRITIS.

Whether or not this pathologic condition of the kidneys is brought about by irritation or inflammation, preceded or not by acute or passive congestion, we recognize but two kinds—acute and chronic; and, again, of the acute, two varieties: (1) Ordinary catarrh of the tubules of the kidney, similar to an ordinary catarrh of the bronchial tubes; (2) a more severe form of catarrh of the urine tubes, characterized by a profuse exudative secretion; this is known as diffuse or croupous nephritis (acute Bright's disease), and would correspond, taking the comparison above, to a severe pneumonitis. The differential diagnosis is made as follows:

In acute catarrhal nephritis we have little or no fever; slight bearing and dragging pains in the sacral region; small show, and sometimes none at all, of albumin, normal or slightly diminished quantity of urine, specific gravity normal, reaction acid, usually decided sediment, but composed mainly of mucus; no edema or anasarca.

In acute diffuse nephritis we have considerable fever, greater feeling of discomfort in sacral region, much edema, and sometimes anasarca so great as to completely disfigure the individual; *large* quantities of albumin in the urine, increased specific gravity, and marked diminution in quantity of water (often only 200 c.c. in twenty-four hours); *large*, sedimentary deposits, composed mainly of urates, blood-coloring matters, and epithelial cells.

CHRONIC PARENCHYMATOUS NEPHRITIS.

Chronic parenchymatous nephritis may be the sequel of an acute attack, but oftener begins as such. The first symptom of this disease is dropsy *without* fever; the specific gravity of the urine is *always* found to be below normal, and has a range, generally, of between 1.013 and 1.017. When the specific gravity falls below this, and shows a lower limit of 1.010 or 1.012, it is an evidence that the nephritis is taking on what may be termed a secondary action, and is going to become an interstitial variety. The quantity of urine passed is generally normal, its reaction decidedly acid, and its color is generally pale yellow. It contains much detritus, frequently consisting of epithelium of the kidney and various cell forms; albumin is *always* found in considerable quantities, ranging from ½ of one to 2½ per cent.

INTERSTITIAL NEPHRITIS.

This disease of the kidneys is frequently a natural consequence of the chronic secondary parenchymatous variety; when it is, the general characteristics are somewhat masked, as the change has been gradual. The great difference, however, shown in the urine is in the smaller quantity of albumin, the increased volume, paler color, and specific gravity ranging lower—1.008 to 1.012. After a little, we note the fibrous change the vascular system has undergone, and see developed a true capillary arteriofibrosis, evidenced by a full, tense pulse, associated with hypertrophy of the heart—most apparent on the left side. Interstitial nephritis, or cirrhosis of the kidney, seldom starts in youth, but most often about the middle of life, and *without* dropsy. For a long time there is really nothing to call attention to the disease, save the condition of the heart and pulse. If, however, together with this indication we find small (yes, sometimes very small, and for days at a time none) quantities of albumin, impairment of vision, *diminished* specific gravity, and a pale-colored urine of normal quantity or else increased, we can safely pronounce the case as one of atrophy of the kidneys. It is *particularly important* in these cases to estimate the urea from time to time, as a means of better forming a diagnosis and prognosis.

As the disease advances, although the volume of water increases the urea falls off, and toward the end seldom shows more than seven or eight grams for the twenty-four hours. The reaction of the urine in this variety of kidney disease is acid, and only becomes neutral and alkaline when the nephritis is of the suppurative variety; when of this latter kind, the odor of the urine is putrid, and it contains blood-coloring matters and *pus*.

The differential diagnosis between interstitial nephritis and amyloid kidney is extremely difficult, as the general characteristics of the urine are about the same. Amyloid kidney, however, has no symptoms of capillary arteriofibrosis, and is generally associated with some constitutional disease, such as chronic tuberculosis, scrofula, malarial cachexia, and syphilis, and is frequently accompanied with a certain amount of dropsy.

There is, however, a condition which from the author's experience seems to be of wide range, of cases showing for long periods *no* albumin in the urine, but in which the absolute of solids and urea decrease and the relative increases, showing for a long time renal insufficiency and at the post-mortem few kidney lesions. These cases seem to him to be true evidence of a low and slow grade of sclerosis, in which either the liver cells or cells of the small intestines refuse to break up food into its final health end products, and thus the kidney excretion shows a great diminution of the same.

These are the cases which are constantly passed by the general examiner of urine, and it is only after a stroke, may be of paralysis, of syncopy or some uremic phenomena, that a more careful examination of the urine is made and with it the startling revelation disclosed of the fall of solids and urea to a point where life can no longer be maintained. See table on pages 80 and 81.

As a further aid in determining whether the insufficiency we have spoken of is functional or organic, the estimation of renal permeability by the phloridzin method, the methylene-blue method and the cryoscopic method may be taken advantage of.

Mering's Phloridzin Method.—Inject $\frac{1}{12}$ of a grain of phloridzin into the subcutaneous cellular tissue; glycosuria is produced; healthy cells eliminating more in the same time than diseased cells; elimination begins in normal cells in about ten or twelve minutes, whereas in diseased ones later on; by the estimation then in one hour of the sugar passed, a fairly good idea can be obtained as to the permeability of the kidneys. Provided the test is frequently applied.

Methylene-blue Method.—Inject $\frac{1}{3}$ of a grain of methylene-blue subcutaneously, and note how soon and how long the blue color continues in the urine. Healthy kidneys excrete it at once and the urine holds the color longer than when they are diseased. This test too must be frequently applied to avoid errors.

The Cryoscopic Method.*—**Cryoscopy** is the name given to the process of determining the depression of the freezing point of solutions. This method is used to determine the molecular concentration of the urine, or the renal permeability, by the freezing point of this secretion.

The process is based upon the following facts:

The freezing point of a solution of a substance in a liquid with which it forms no chemical union, is lowered below that of the solvent, in direct proportion to the number of molecules of dissolved substance in a given volume of a solution, or its molecular concentration.

This law applies to a solution of several substances in the same solvent, as well as to solutions of one substance. The depression of the freezing point of aqueous solutions is, therefore, a measure of the number of molecules in that solution.

The number of these mixed molecules in an appreciable volume of urine, say 1 c.c., is very great. For present purposes the relative number is all that is needed. The simplest form of apparatus for determining the freezing point of urine is that of Claude and Balthazard (Fig. 26). It consists of a tube

*From Prof. Bartley's Physiological and Clinical Chemistry. Third Edition.

"*a*," the freezing vessel, and "*b*," an outer tube to protect "*a*." The space between these two tubes is partly filled with alcohol to serve as a conductor. The cylinder *A* is filled three-fourths full with ether

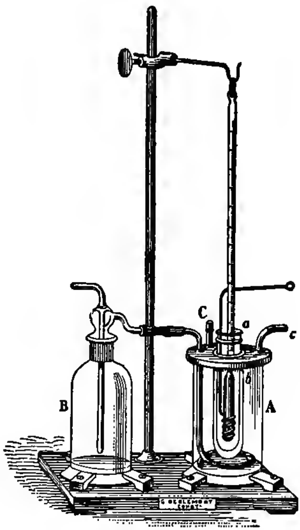

FIG. 26.—Apparatus for determining freezing point of urine. (Bartley.)

or carbon disulphide. The wash bottle *B* contains a small quantity of H_2SO_4 to dry the incoming air. The tube *c* is connected with a water aspirating pump, and a current of air drawn through the apparatus, which escapes from numerous small holes in the metal inlet tube, coiled on the bottom of the cylinder *A*, causing the ether to evaporate rapidly, thus producing a low temperature. The temperature can be regulated, or kept constant, by regulating the current

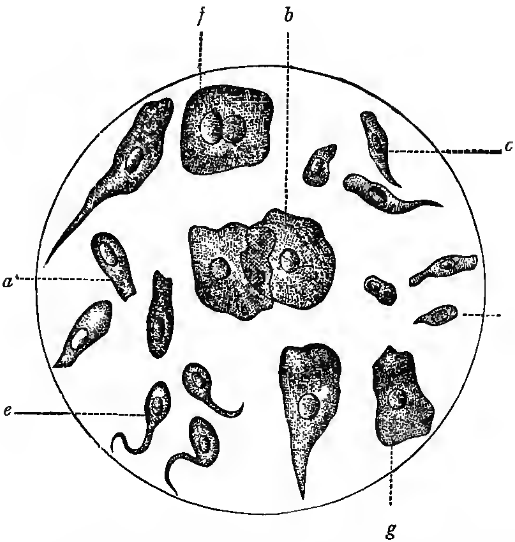

FIG. 27.—(*a*) Epithelial Cells from the Male Urethra; (*b*) from the Vagina; (*c*) from the Prostate; (*d*) Cowper's Glanks; (*e*) Littre's Glands; (*f*) Female Urethra; (*g*) Bladder.

of air. The liquid, whose freezing point is desired, is placed in the tube "*a*," ether or carbon disulphide is put in *A*, the vessel made tight, the thermometer, which should read hundredths of a degree, is suspended in the liquid to be frozen, with the platinum wire stirrer adjusted as seen in the cut, and the pump started.

From time to time the stirrer is moved up and down, until the thermometer becomes stationary at a little below 0° C. To cause the solution to freeze, scrape off a little frost from the outside of *A* and add it to *a*. It is not necessary to wait until the liquid is all frozen, but until a part is congealed. The temperature at which normal urine freezes is usually — 1.30° C. to — 2.20° C. The extremes are seldom met in health.

The depression of the freezing point is usually represented by $\triangle$. The depression of the freezing point, expressed in hundredths of degrees, may be *arbitrarily* used to represent the relative number of molecules dissolved in a given volume, say 1 c.c. If we represent the number of c.c. of urine voided, in 24 hours by V, then the total work done by the kidneys in 24 hours will be represented by $V \times \triangle$. To make more accurate the comparison in different individuals, we must take into the calculation the body weight of the individual. If we designate this weight in pounds or kilograms (2.2 lbs.) by P, the total daily work of the kidneys per lb. or kilo. of body weight will be represented by

$$\triangle \times \frac{V}{P}.$$

Example.—A certain urine gave a depression of freezing point ($\triangle$), of 1.20° C. The volume of urine was 1,200 c.c. The weight was 60 kilogrammes (132 lbs.). The work of the kidneys in this case was $120 \times 1{,}200 \div 60 = 2{,}400$ for each kilo. of body-weight. Or, each kilo. gave 2,400 arbitrary molecules of urinary solids in 24 hours.

In health this number should be between 3,000 and 4.000. In pathological conditions the number is above or below these limits. A part of these molecules are inorganic, chiefly NaCl, filtered through the glomeruli with the water, and the rest organic, separated from the blood by the tubular epithelial cells. According to the theory of Ludwig, as modified by Koranyi, there filters through the glomeruli nearly a pure solution of NaCl, containing too small a quantity of the other inorganic salts to appreciably affect the freezing point. This solution is concentrated in the tubules, by the absorption of a part of the water, and by an exchange between this solution and the blood serum of a certain number of NaCl molecules for an equal number of organic molecules. A determination of the relative number of molecules of NaCl, and of organic molecules, will enable us to measure the part played by the parenchyma or glomeruli, and that played by the tubular epithelial cells, in the formation of the urine in question. Sodium chloride is easily determined by titration. (See p. 27.) One per cent. of NaCl (10 grms. per liter), is known to depress the freezing point 0.605°

C. The per cent. of NaCl multiplied by 0.605 will give the amount of depression caused by the NaCl present, and the remainder of the observed depression will be due to the organic molecules. We can thus determine the relative number of molecules separated by the glomeruli and the tubular epithelium. The latter is often designated by the sign δ.

Example.—A certain urine gave a freezing point of—1.20° C. The titration of the NaCl gave 1.5 per cent. The quantity of urine in 24 hours was 1,200 c.c. and the body-weight was 60 kilos. Then

$$\frac{.605 \times 1.5 \times 1{,}200}{60} = 1{,}800 \text{ arbitrary molecules of NaCl.}$$

The total number of molecules was

$$\frac{120 \times 1{,}200}{60} = 2{,}400.$$

The organic molecules were found by deducting 1,800 from 2,400, leaving 600 molecules as those elaborated by the epithelial cells of the tubules.

These two formulæ,

$$\frac{\Delta + V}{P},$$

or the expression of the *total molecular diuresis*, and

$$\delta \times \frac{V}{P},$$

or the expression of the molecular exchange or activity of the tubular epithelium, are two important working formulæ.

The quotient obtained by dividing the total depression by that due to the elaborated (organic) molecules, $\triangle / \delta$ is also of use. This quotient in normal urines is from 1.5 to 1.7 and not outside of these limits. When

$$\frac{\triangle V}{P} = 3{,}000, \frac{\triangle}{\delta} = 1.5$$

and when

$$\frac{\triangle V}{P} = 4{,}000, \frac{\triangle}{\delta} = 1.7$$

In nephritis this last ratio may sink to 1.1, and in cardiac insufficiency it may rise to 2.5. This factor is often of great use in showing degeneration of the heart muscle, even when no abnormal heart sounds can be heard with the stethoscope.

Cryoscopy of the urine is sometimes of great value in the diagnosis of both renal and cardiac disorders, as well as certain disorders of metabolism.

We may state the chief uses of cryoscopy of the urine as follows:

1. To determine cardiac sufficiency, or insufficiency, with certainty even when the stethoscope fails.

2. To determine which portion of the renal structure is functionally deficient, and the degree of that deficiency.

3. To prognosticate uremic accidents with exactness.

4. In conjunction with catheterization of the ureters, we may determine whether one or both kidneys are the subject of disease, and the relative functional power of each.

5. By it the fact has been established that functional permeability of the kidneys in most forms of nephritis is intermittent. There are periods of entire permeability followed by periods of reduced permeability, and consequent danger of uremia.

6. When one kidney is to be removed, for any cause, a cryoscopic examination of the urine from other one should be made to determine its condition, unless this can be done by the phloridzin or methylene-blue method. Cryoscopy is more certain and more quickly done, and when combined with cryoscopy of the blood it becomes of great value in the diagnosis.

PYELITIS AND CYSTITIS.

Inflammation of the pelvis of the kidney and of the ureters and bladder frequently occurs. Though much has been written in regard to the differential diagnosis of these conditions, it is of no real practical utility, since a cystitis will, if not cured, set up inflammation higher up the canal, and vice versâ. For practical clinical purposes, therefore, I will disregard much of this, and will say that when the pelvis of the kidney and the ureters are alone affected it is called pyelitis; when, however, the inflammation extends to the bladder, it is called cystitis. If the pelvis of the kidney is the principal seat of inflammation, it is designated as cystopyelitis; if, on the other hand, the bladder is the center of inflammation, it is called pyelocystitis. These inflammations may be acute or chronic, but in all we find *pus*. A differential diagnosis is approximately made as follows:

Acute and chronic inflammations of the pelvis of the kidney and ureters are attended with *acid* urines, *albumin*, and pus; acute inflammations of the bladder, with neutral or alkaline urine, pus, but *no* albumin.

Inflammation of the pelvis and ureters is accompanied by polyuria; inflammation of the bladder, *never*. Specific gravity in pyelitis is generally below normal; specific gravity in cystitis, normal or above. No particular frequency in making water in pyelitis; constant desire to pass water in cystitis. Besides these differential points, the microscope may be used for the identification of renal or else of bladder epithelium, as the case may be.

Should the cystitis, as is sometimes the case, be very severe, we will then find not only pus, but *albumin* in the urine. To differentiate this from pyelitis, we must refer to the specific gravity and reaction: In pyelitis it is generally below normal, and reaction acid or *just* neutral; in cystitis (severe), specific gravity is normal or above, and reaction *intensely alkaline*, due to presence of *ammonia carbonate*, and occasionally to ammonium sulphid. In doubtful cases the urine must be drawn for examination, by means of a rubber catheter, directly from the kidney, *guttatim*.*

Apparatus required for executing all the tests contained in this volume:

1. Test-tubes, one dozen.
2. Small funnels—½ of an ounce, 6; four ounces, 6.
3. Glass rods, different sizes, 6.
4. Watch-glasses, 6.
5. One nest of beakers.
6. One wash-bottle, twelve ounces, for water.
7. Porcelain evaporating dishes, 6.
8. Small conic test-glasses, 6.
9. Water-bath.
10. Spirit-lamp.
11. Small piece platinum foil.
12. One pair of pincers.
13. Small chemic balance (only necessary, however, if gravimetric estimations are to be made).
14. One urinometer float (with temperature chart).
15. Microscope with appurtenances.
16. One Esbach's albuminometer.
17. One Doremus' ureometer.
18. One Mohr's burette, fifty c. c., graduated in tenths.

*In all urine examinations the entire quantity for twenty-four hours should be known, and a portion of this taken for analysis. In case this provision can not be carried out, the urine passed on rising in the morning will give the best approximate results. One gram is equivalent to 15.44 grains; thirty c. c. are equivalent to one ounce.

If specimens of urine have to be sent for examination from a distance, first measure the quantity for the twenty-four hours; then take its specific gravity, and to six ounces of the mixed urine add one tea spoonful of Squibb's chloroform, and send the same for analysis. The addition of the chloroform keeps the urine from fermenting.

19. Two sizes cut filter-paper for funnels, as stated.
20. Blue and red litmus-paper.
21. One liter flask.
22. One 200 c. c. flask.
23. One 10 c. c. pipette.
24. One measuring jar for measuring urine, to hold ninety c. c. and graduated in $\frac{1}{10}$ of a c. c. divisions.
25. One-half dozen flasks; sizes, four and six ounces.
26. Small quantity assorted glass tubing.
27. Three or four feet india-rubber tubing.
28. One pipette, to deliver five c. c.
29. One-eighth gross assorted corks.
30. Filter stand, test-rack stand, and ring stand.
31. One Ruhemann's Uricometer with *long* shank pipette.

Chemicals required for executing all the tests in this volume:

1. Water, distilled, or very pure rain-water.
2. Alcohol, methylated, for lamp.
3. Old oil of turpentine.
4. Ozonized ether.
5. C. p. hydrochloric acid.
6. C. p. sulphuric acid.
7. Picric acid, solution six grains to the ounce of water.
8. Glacial acetic acid.
9. Ordinary acetic acid (sp. gr. 1.04 to 1.045).
10. Potash and soda in sticks.
11. Potash in solution (strength, one part to three parts H_2O).
12. Rochelle salts.
13. Cupric sulphate.
14. Ammonia molybdate.
15. Silver nitrate solution (one part of $AgNO_3$ to eight of water).
16. Citric acid.
17. Ammonia.
18. Lead acetate solution (1:8 of water).
19. Sodium hyposulphite.
20. Ammonium nitrate.
21. Solution of bromin.
22. Ferrous sulphid.

23. Potassium ferrocyanid.
24. Freshly prepared tincture of guaiacum.
25. C. p. sodium chlorid.
26. C. p. nitric acid.
27. Sodium nitroprussid.
28. Chlorid of zinc.
29. Phosphotungstic acid.
30. Sulphanilic acid.
31. Sodium nitrite.
32. Solution chlorinated soda.
33. Sodium sulphate.
34. Bismuth subnitrate.
35. Ten per cent solution of *a*-naphthol in pure methyl or ethyl alchohol.
36. Five per cent. solution of chromic acid.
37. Iodin: C. p. potassium. Iodid, c. p. absolute alcohol. Carbon bisulphid. Bichramote of potassium.
38. Phlorizin.
39. Methylene-blue.

The reagents used, unless stated otherwise, are solutions in water (1:15).

TABLE FOR CALCULATING THE ABSOLUTE SOLIDS IN URINE OF SPECIFIC GRAVITIES RANGING FROM 1.004 TO 1.030.

Column A.			Column B.		
Multiply by Number of Cubic Centimeters of Urine Passed in Twenty-four Hours.			Multiply by Number of Fluidounces of Urine Passed in Twenty-four Hours.		
Sp. gr.	1.004	0.00932	Sp. gr.	1.004	0.2796
" "	1.005	0.001165	" "	1.005	0.3495
" "	1.006	0.01398	" "	1.006	0.4194
" "	1.007	0.01631	" "	1.007	0.4893
" "	1.008	0.01864	" "	1.008	0.5592
" "	1.009	0.02097	" "	1.009	0.6291
" "	1.010	0.02330	" "	1.010	0.6990
" "	1.011	0.02563	" "	1.011	0.7689
" "	1.012	0.02796	" "	1.012	0.8388
" "	1.013	0.03029	" "	1.013	0.9087
" "	1.014	0.03262	" "	1.014	0.9786
" "	1.015	0.03495	" "	1.015	1.0485
" "	1.016	0.03728	" "	1.016	1.1184
" "	1.017	0.03961	" "	1.017	1.1883
" "	1.018	0.04194	" "	1.018	1.2582
" "	1.019	0.04427	" "	1.019	1.3281
" "	1.020	0.04660	" "	1.020	1.3980
" "	1.021	0.04893	" "	1.021	1.4679
" "	1.022	0.05126	" "	1.022	1.5378
" "	1.023	0.05359	" "	1.023	1.6077
" "	1.024	0.05592	" "	1.024	1.6776
" "	1.025	0.05825	" "	1.025	1.7475
" "	1.026	0.06058	" "	1.026	1.8174
" "	1.027	0.06291	" "	1.027	1.8873
" "	1.028	0.06524	" "	1.028	1.9572
" "	1.029	0.06757	" "	1.029	2.0271
" "	1.030	0.06990	" "	1.030	2.0970

To determine the quantity of solids, expressed in grams, multiply the number of cubic centimeters of urine passed in twenty-four hours by the figures found in Column A corresponding to the specific gravity of the urine under examination, and the result of such multiplication will represent the number of grams excreted. If the calculation is to be made from the fluidounces of urine voided, multiply the number of fluidounces of urine passed in twenty-four hours by the figures in Column B corresponding to the specific gravity of the urine examined, and the result will express the solids, in grams also.

STATEMENTS OF THE RESULTS OF A COMPLETE ANALYSIS OF URINE.

Analysis, No.......................... Date,..

Patient's Name,..

Urine Passed in Twenty-four Hours,...

Reaction,..

Specific Gravity,...

Color,.. Odor,...

Consistence,.................................. Transparency,...................................

Albumin.—Very much—Considerable—Slight—Trace—None. (Erase those words not expressing.)

Sugar.—Very much—Considerable—Slight—Trace—None. (Erase those words not expressing.)

Absolute Solids, ... grams.
" Urea, ... "

Relative Absolute Solids, ... "
" " Urea, ... "

Chlorides.—Normal—Increased—Diminished. (Erase condition not found.)

Phosphates.—Normal—Increased—Diminished. (Erase condition not found.)

Uric Acid.—Normal—Increased—Diminished. (Erase condition not found.)

Detritus.—Urates—Bladder cells—Kidney cells—Urethral cells—Vaginal cells. (Erase those not found.)

Coloring-matters.—Urobilin—Acetone—Indican—Peptone—Bile—Leucin—Tyrosin.

Blood.—Red corpuscles—White corpuscles—Pus—Mucus. (Erase those not found.)

Tube-casts.—Hyaline—Epithelial—Granular—Epithelial or Hyaline with Oil drops—Mucous casts—Urate cylinders—Urate casts simulating tube-casts. (Erase those not found.)

Extra sedimentary deposits in a calculus, what variety? ....

Ehrlich's typhoid test.

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