PYURIA.*

INTRODUCTION.

When more or less pus is passed in urination, we call the condition pyuria. It is, of course, evident that when we use the term *pyuria* we make a diagnosis in a very general way only. Like so many other expressions much used in former times, it is now seldom employed to express a disease in itself. It is like hæmaturia, albuminuria, etc. With the progress of medical diagnosis, these general terms gradually vanish; and thus pyuria may be applied to several diseases of the apparatus designed for secreting, containing, and carrying off the urine, which can be accurately diagnosticated, by careful instrumental examination of the patient, and especially by a microscopical and chemical investigation of the urine.

In the following pages we will give all those aids which can help us to a special diagnosis as to what portion of the urinary apparatus is secreting the pus. Before doing this, we will discuss pus in its general relations, as the most important constituent of pyuric urine, and at the same time the best means to determine its presence.

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PYURIA.

Pus.—Pus consists of cellular elements, the pus-corpuscles, which are suspended in a fluid, pus-serum. Urine containing pus must admit of the detection of both these constituents, the pus-corpuscles as well as the serum. The pus-corpuscles are determined usually by the microscope; the pus-serum, on the contrary, by chemical means, on account of the presence of albumen. Since pus consists of cellular elements, it necessarily follows that urine containing pus will appear more or less *turbid*, and turbid just in proportion to the amount of pus. A urine which has just been passed, and which appears clear and transparent, can never contain pus. The color of a pus-urine corresponds to the amount of coloring matter in the urine at the time, sometimes a lighter, again a darker wine-yellow; pus itself has a greenish-yellow color; this is, however, only imparted to the urine when it is present in large amount. The natural color of the pus is evident when it has separated from the urine as a compact sediment. Pus has an alkaline reaction, but the quantity of alkali is usually not enough to exert any considerable influence on the reaction of the urine. The acid reaction of the urine can only be neutralized or overcome by the alkali of the pus-serum when pus is present in a very great amount.

Pus-Corpuscles. — Pus-corpuscles are identical in shape and appearance with mucus-corpuscles, as well as with lymph and white blood corpuscles. Consequently, we can not always say, after simply examining a urinary sediment with the microscope, whether a given urine

contains pus or only increased catarrhal secretion. Here the chemical examination puts us right. If the urine contain at the same time an amount of albumen corresponding to the quantity of corpuscles, and if these latter can have no other source than the pus-serum mixed with the urine, we infer the presence of *pus*. If, on the contrary, the urine contain no albumen, increased ca-

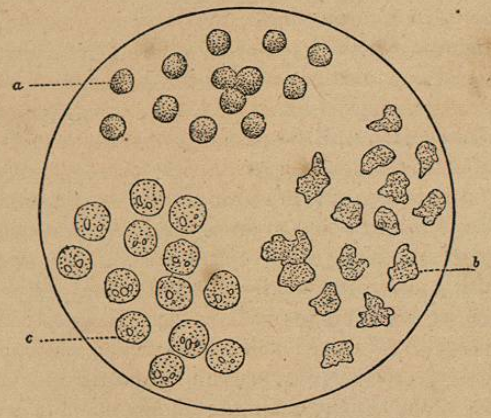

FIG. 1.—*a*. The usual globular pus-corpuscles of acid urine. *b*. Irregular pus-corpuscles of acid urine, provided with processes. *c*. Swollen pus-corpuscles of a strongly dilute or alkaline urine, with visible nuclei.

tarrhal secretion only is present. Pus-corpuscles always appear colorless under the microscope. They are somewhat larger than the red corpuscles, they have a diameter of $\frac{1}{80}$ to $\frac{1}{100}$ micro-millimetre, and they seem to be heavier than the latter, since, if we allow a sample of urine containing both blood and pus corpuscles intact to settle, the pus will form the lowest layer, while above, resting upon the green-yellow layer of pus, will be seen

a bright red covering of red corpuscles. Pus-corpuscles are seen in two forms in acid urine : they are either globular or else irregular, sending out processes. The first is the variety most frequently met with. *Vogel* called attention to this difference in pus-corpuscles in the urine, and declared that their occurrence in the irregular form afforded a much less favorable prognosis than when they are globular. As a matter of fact, in those obstinate forms of pyuria which last for years, we find, as a rule, variously formed pus-cells, while in the milder and more transitory purulent catarrhs of the urinary passages, the globular form predominates. As a rule, the microscope shows us *either* the globular or else the polymorphous pus-corpuscles in a given urine, rarely both forms in the same urine, yet in exceptional and unusual cases both varieties may occur at once. Pus-corpuscles appear slightly granular and show no nucleus. They alter in a given urine according to the concentration and amount of saline constituents, as well as according to the reaction to litmus. In acid and concentrated urine, rich in salts, the pus-cells appear small and granular ; in alkaline urine, on the contrary, or in one of low specific gravity, they appear large and swollen ; the granulation of the protoplasm has vanished and the nuclei are plainly visible. In a very watery urine, the pus-corpuscles may appear two or three times as large as in a urine of normal concentration. This is the well-known change which pus-cells undergo when treated with distilled water. The alkalies, especially the carbonate of ammonia, of a urine undergoing alkaline fermentation, cause the pus-cells to swell still more, and they finally break up into a mass in which we no longer see the outline of the cells, but only the nuclei thus set free. A solution of iodine in potassic iodide colors the pus-corpuscles a fine yellow,

while the nuclei which are now seen appear darker, and of a brownish-yellow color.

Pus-Serum.—Pus-serum, the intercellular fluid of the pus-corpuscles, is an opaque, pale-yellow fluid, always having an alkaline reaction. The alkaline reaction of the pus-serum arises from carbonates and basic phosphates of the alkalies and alkaline earths. The chief constituent of pus-serum is, however, serum albumen. Serum albumen of pus is not different from that of blood-serum. Moreover, pus-serum contains some paraglobulin and an alkali-albuminate. Since it is evident from the preceding that a pus-containing urine must be more or less opaque, and also contain an amount of albumen proportional to the pus, in order to detect the presence of the pus we proceed as follows, by what is, on the whole, the best method : Fill a test-tube half full with the urine to be tested, and heat gradually the upper half of the column of fluid to boiling. An increase of the opacity in the portion so heated, as compared with the lower portion which has not been boiled (as seen against a black background), indicates the presence of pus, if this increased opacity remains after the addition of one or two drops of acetic acid. The opacities in urine are briefly compared in the following table. This is, to be sure, not infallible, but it will always be of good service to the practitioner, on account of its simplicity, and the ease with which the tests may be made.

By gradually heating a given urine to boiling, the opacity—

Vanishes.	Increases.		Remains unchanged, even after addition of acetic acid.
If due to acid urates.	If due either to *earthy phosphates* (phosphaturia) or to *pus-corpuscles*. Add one or two drops of acetic acid:		The dimming is caused by cloudy *catarrhal secretion*, or by *bacteria*.
	The dimness vanishes.	The dimness remains.	
	Phosphaturia.	*Pyuria.*	

If, on the contrary, the supposed pus, after the urine has settled, forms a yellowish-white precipitate in the glass, visible to the naked eye, we carefully pour off the fluid above it, and add a few drops of a concentrated solution of caustic potassa (one third of water), shaking the vessel meanwhile until a visible change takes place. Now, if the sediment consists of pus, and if it is in the fine flaky state, with acid reaction of the urine (as, for example, in pyelitis), the entire sediment on addition of the caustic potassa (or caustic soda) will become transparent, thick, jelly-like, or at least capable of being drawn out in threads.

The change in the consistence of the purulent sediment in this test is occasioned by the transformation of the albumen in the pus into a glutinous, semi-fluid alkali-albuminate (Donne's pus test). If, on the contrary, the white pulverulent sediment consists of earthy phosphates, it will remain unaltered after the addition of caustic potassa or caustic soda, and retain its fluid consistence (can still be poured out in drops). This transformation of the pus into a transparent, tenacious, semi-fluid

mass takes place sometimes even in the bladder itself, as in purulent vesical catarrh with ammoniacal fermentation of the urine, and is here occasioned by the carbonate of ammonia which is present. Likewise, these greenish-yellow, tenacious masses, resembling the discharge of nasal catarrh, which cling to the sides of the glass, are not composed of vesical mucus, but of alkaline pus. If retention of urine exists, along with pyuria and ammoniacal fermentation, and if much pus be present, this will be gradually changed into a honey-like, homogeneous, tenacious fluid, which flows off slowly when the catheter is passed, and on cooling takes on a sirupy consistence. On examining this urine microscopically, the contour of the pus-corpuscles can no longer be seen distinctly. We find simply their free nuclei. If an ulcerative process is present at the same time with pyuria in the urinary apparatus, the pus becomes ichorous, as is generally the case in an ulcerating neoplasm of the bladder. The urine at the same time has a dirty, greenish-brown color, and a penetrating, disagreeable, stinking odor, sometimes resembling fæces, sometimes ammonium sulphide. Such a urine has at the same time a strongly alkaline reaction. These are the urines which turn silver catheters black when employed in relieving the patient. Such a urine contains both considerable albumen and much blood-pigment. In the sediment, however, neither pus nor blood cells are to be seen, nor any epithelial structures. All cells are destroyed, and under the microscope we find only considerable detritus, triple phosphate, and bacteria in large amount. The penetrating odor developed by such a urine, which is made much more intense, sometimes indeed unendurable, by adding a mineral acid, may arise partly from the decomposition of albuminous bodies in the bladder, but

also partly because in ulcerative vesical processes (likewise in parenchymatous cystitis) a diffusion of intestinal gases into the bladder takes place readily. A similar occurrence often takes place in abscesses or inflammations in the neighborhood of the intestines, as in perityphlitic abscesses, into the fluid within the sacs of incarcerated hernias, etc.

The pus which is passed with the urine may have a twofold source. It may have been formed on the surface of the mucous membrane of the urinary tract, or, on the other hand, from the parenchyma of certain portions of the same, and is then genuine *abscess-pus*. As the latter, it may also originate from purulent exudations and abscesses situated around the urinary tract, and which have opened into it. Thus abscesses of the kidney or prostate, purulent parametritic and pericystitic exudations and other abscesses, not infrequently empty into the bladder, and thus form the chief constituent of a purulent sediment in a given urine. The varying amount of pus present in a urine in such cases is in itself presumptive proof of an addition of abscess-pus to the urine. However, certainty is only afforded by microscopic examination of the sediment. That is to say, if the pus comes from the mucous membrane alone, we find microscopically, in addition to numerous pus-corpuscles, the epithelium of the inflamed mucous membrane. If, however, the pus comes from an abscess cavity which has opened into the urinary tract, the granular cells, or the so-called inflammation cells, which are always easy to recognize, are never absent. Pus-corpuscles, under the microscope, appear sometimes as solitary cells, sometimes conglomerated, again they are polymorphous, cohering masses. As conglomerated masses they not seldom arise from the small ducts of the accessory glands

of the urinary tract, or from the papillary* layer of the kidney itself, and they then take on a cylindrical form. From the character of the epithelial cells imbedded in these cylindrical casts, for example, whether covered with renal epithelium or spermatozoa, we derive in certain cases further information as to the source of the pus.

Pus, as passed with the urine, may come from the most diverse portions of the urinary tract. We can determine the following regions of its origin by the manner of urination itself, or by the more exact microscopic and chemical examination of the urine :

1. Pus arising from any part of the urethra, from the meatus to the compressor urethræ.
2. Pus arising from the neck of the bladder or the prostatic part.
3. Pus arising from the bladder.
4. Pus arising from the pelvis of the kidney and the kidney itself.

* These must not be confounded with the "gonorrhœal threads" to be described further on, and which are merely urethral epithelium rolled up into cylinders visible to the naked eye.