subcapsular abscesses were yellow. The pus in the pelvis was similar in color. There was no sign of methylene blue in its blue state. The diagnosis of pyelonephritis was thus verified at operation.

After this operation the patient did very well and the nephrotomy wound gradually closed. On March 17, 1907, there reappeared a methylene blue stained specimen. Since February 11 there had been no sign of this coloring matter. During the following week two other specimens of blue stained pus appeared.

Nephrectomy.—As the wound in the kidney closed the patient ran high temperature, which finally, on April 8, 1907, demanded a nephrectomy. The kidney was completely changed. Instead of a large solid organ with multiple small abscesses, the kidney was converted into a large, soft, fluctuating organ full of pus, a pyonephrosis, with a newly formed conglomerate calculus in the beginning of the ureter. In the remains of the kidney there were none of the old parenchymatous abscesses. In the large quantities of pus that were lost during the operation, no blue discoloration was noted. Unfortunately, all this pus was not collected for chemical examination, as it is more than probable that the methylene blue is deposited in its leuco form, and does not betray its presence by its typical blue color.

If this case be analyzed as to the source of the blue stained pus it at once becomes evident that it could not come from the bladder, as that organ had been very frequently irrigated and also inspected with negative results. From the pelvis it could not come, as this, in addition to being irrigated repeatedly, had also been opened by direct incision and drained. The only possible source that is left us is in the multiple small abscesses in the kidney parenchyma.

Before closing there are several points that I wish to refer to briefly. I do not know whether the methylene blue is excreted in these cases in the blue as well as in the white form. I am inclined to think, but am by no means sure, that it may be excreted in either form, for I have noticed that specimens which I looked at shortly after passage were blue and became bluer and bluer on standing, the white or leuco-methylene blue being gradually converted into the blue form. Another peculiarity occasionally noted was the breaking up of the chemical combination in which the pigment was bound and the progressive staining of the supernatant fluid; this conversion of the fixed and insoluble methylene blue into a soluble substance probably resulted from the action of bacteria, as in specimens bottled with chloroform such changes never occurred.

These remarks will give some insight into the difficulty of recognizing the pigment as it is deposited in the tissues. That we can not rely on its blue color alone for its recognition is evident, for it is more than likely that it is fixed in the pus, etc., in its leuco form. In the kidney that I removed in Case 2, the material was so changed that it was unsuitable for the proper elucidation of this point. Up to date my experimental work along these lines is not ready for publication; still this work indicates, as you will see in the specimen later referred to, that the pigment is deposited in great part, if not wholly, in its leuco form.

The last point that I wish to refer to relates to the time and manner of the deposition of the methylene blue. I feel sure that it is not found in all abscesses of the kidney, as I have had occasion to examine some pus from large abscesses after administration of the drug and failed to recognize the pigment. More than likely the presence of methylene blue in the abscesses is the result of the excretion of the renal epithelial cells. One might suppose that the ascending infection in the collecting

tubules leads to a stenosis behind which the methylene blue is excreted and the developing abscess thus receives its quota of pigment.

As evidence in favor of this view, I would show these specimens taken from a dog, in which I had produced an ascending pyelonephritis. Methylene blue was administered daily for several days following the operation and the kidney was removed about two weeks later. This specimen when fresh showed very little pigmentation, but after treatment with oxidizing agents, even after fixation in alcohol, shows, as you can readily see, multiple grayish-blue pus foci throughout the organ. These areas lose their color if treated with reducing agents and regain the same on subsequent oxidation.

On the other hand, as yet, I have not recognized the pigment in the pus of old thick-walled abscesses. If such old abscesses progress and involve adjacent tubules, I naturally would expect to find methylene blue in goodly amounts in them, provided my explanation of this whole phenomenon is correct.

SUMMARY.

If, then, I should summarize the above clinical and experimental data, I would state:

1. There is no differential diagnostic sign between simple pyelitis and pyelonephritis.
2. Pyuria from the upper urinary tract may be due to either of these conditions.
3. By the use of the above described methylene blue test it would seem that a differential diagnosis may be made.
4. Methylene blue is deposited in the parenchymatous abscesses and may be stored in these for years.
5. A late discharge of methylene blue, bound to the pus, is indicative of the rupture of such parenchymatous abscesses into the pelvis of the kidney, and is consequently diagnostic of pyelonephritis.

MENINGOCOCCUS SEPTICEMIA.

DEMONSTRATION OF THE MENINGOCOCCUS IN THE BLOOD SMEAR.

CHARLES E. SIMON, M.D.

Professor of Clinical Diagnosis at the Baltimore Medical College.
BALTIMORE.

The number of cases of meningococcus infection in which the organism has been found in the blood is as yet rather small, and the one described below, in which it could be demonstrated directly in the blood smear taken from the ear, so far as I have been able to ascertain, is the only one now on record.

Patient.—A man, aged 27, whose family and previous personal history contained nothing of importance. He had been in good health until the night of March 19, when he complained of pain in the head and neck and also in the joints and muscles. He was nauseated, but did not vomit. Within the next days the headache became progressively worse and very severe. There had been no distinct chill, but fever up to 104 F.

Examination.—He was admitted to Dr. Fletcher's service at the St. Agnes Hospital at 11:30 p. m. March 23, in a condition of marked stupor, from which he could be aroused only with difficulty. When I saw him, March 24, about noon, he was profoundly unconscious. There was marked dyspnea; the pulse was just perceptible at the wrist. On both feet, over the flexor surfaces of both forearms and the anterior surfaces of the legs there were numerous ecchymoses. The man's face was mark-

1. I am indebted to Dr. Fletcher for permission to use the clinical notes referring to the patient.

edly cyanotic, and about the nostrils there was an abundant herpetic eruption. There was evident rhinitis and conjunctivitis. Kernig's sign was present, as also moderate retraction of the head. On lumbar puncture, a small amount of hemorrhagic, markedly turbid fluid was obtained. Death occurred about an hour later. An autopsy unfortunately could not be obtained.

Examination of the Fluid.—In the meningeal fluid, coffee-bean shaped diplococci could be demonstrated both within and outside of the cells, which latter were almost all polynuclear elements. The organisms were not numerous, however. Some were small, others presented a swollen appearance, while a few occurred as tetrads.

Blood smears showed a leucocytosis of high grade—50,000 at a conservative estimate, with the following relative values: Small mononuclears, 17 per cent.; large mononuclears, 21 per cent.; polynuclear neutrophils, 62 per cent.; eosinophiles and mast cells, none in a count of 500 cells. Fully 8 per cent. of the leucocytes contained diplococci, which in their morphologic habitus could not be distinguished from those found in the meningeal fluid of this case, nor from diplococci isolated by culture from other typical cases of meningococcus meningitis. Like these, they were Gram negative. It is noteworthy that the large mononuclear leucocytes were engaged in phagocytosis almost to the same extent as the neutrophils. While in the majority of the phagocytizing cells only one or two pairs of diplococci were seen, others were literally studded with them. One large mononuclear contained 26 pairs, and a neutrophil between 50 and 60 pairs. Extracellular organisms were also encountered, but were not numerous.

The bare figures give hardly a proper idea of the extent of the septicemia. But calculating the degree of leucocytosis at at least 50,000 cells in each c. mm. and that 73.8 pairs of cocci were found in 500 leucocytes, it would follow that in one c. mm. of blood there were 7,380 and in one cubic centimeter 7,380,000 diplococci, the vast majority of which had been disposed of by phagocytosis. As a general rule the organisms were well preserved and stained deeply with methylene blue, but in some cells they were greatly diminished in size and manifestly undergoing dissolution. Many neutrophils were vacuolated to a considerable extent, suggesting that digestion of the cocci had occurred in the vacuoles; in some, indeed, basophilic debris could still be discerned (see illustrations).

Similar appearances were seen in some of the large mononuclear leucocytes, which latter were also engaged in the phagocytosis of red cells. The increase in both the relative and absolute number of these latter is especially noteworthy. In the relatively small number of meningococcus meningitis cases (10) in which I have made differential counts before, I did not meet with this feature. There was always a polynucleosis of high grade with low mononuclear values. It would be tempting to bring these cells into a connection with a possible proliferative endarteritis, but in the absence of an autopsy this hardly seems warrantable. The significance of their presence and identity must hence remain an open question.

REVIEW OF LITERATURE.

The first case of meningococcus septicemia in which the organism was found in the blood (by culture) is reported by Gwyn.² The patient was a man, aged 24, with symptoms of meningitis, swelling and redness of both elbows, the right wrist, the right knee and several of the smaller joints of the hands. Growths were obtained on the day preceding death (the fifth of the disease) from the meningeal fluid, the pus from the knee joint and the blood.

2. Bull. Johns Hopkins Hosp., June, 1899. This case is also reported by Osler, Boston Med. and Surg. Jour., vol. cxxxix.

The second case is reported by Salomon.³ There were symptoms of meningitis, associated with pain and swelling of several joints (wrists, elbows and ankles). The organism was cultivated from the blood on the eighth day of the disease and was also demonstrated in the meningeal fluid.

In his communication Salomon also refers to a statement by Jäger⁴ to the effect that in one case he had been able to cultivate the meningococcus *intra vitam* from the urine.

The third case is described by Warfield.⁵ There were no definite symptoms of meningitis, but at autopsy (brain not examined) an acute ulcerative endocarditis was found. The organism was isolated by culture from the blood during the life of the patient (about the twenty-sixth day of the disease) and postmortem from the vegetations on the valves. This case is the first re-

Blood in meningococcus septicemia.

corded in which the meningococcus was demonstrated to be the cause of a malignant endocarditis.

Two additional cases are reported by Martini and Rohde.⁶ In both meningeal symptoms were observed, but in the one they only appeared after three or four weeks of general illness. The organism was isolated from the blood in both cases. Their demonstration in bouillon cultures deserves especial mention. A series of bouillon tubes were inoculated, each with about 2 c.c. of blood and incubated at 37.5° C. After sixteen hours the organisms were found—many of them intracellularly in leucocytes. The search was greatly facilitated

3. Berlin klin. Wochschr., 1902, No. 45.

4. Die epidemische Meningitis als Heeresseuche, Coler, Berlin, 1901.

5. Warfield: University of Penn. Medical Bull., July-August, 1903.

6. Berlin klin. Wochschr., 1905, No. 32.

by centrifugalizing the bouillon cultures containing the blood and examining the leucocytes in the surface layer of the centrifugate.

The writers are manifestly not aware of Gwyn, Salmon and Warfield's findings, as they regard their cases as the first in which the meningococcus has been demonstrated in the blood.

The only additional cases in which this demonstration has apparently been made are two instances of meningitis, recorded by Follet and Sacquépée.⁷

Including my own there are thus only eight cases in which the meningococcus has been found in the blood. This is a remarkable fact considering the large number of cases of meningococcus meningitis which have been observed within the last few years; but it may find its explanation in the small number of blood examinations which have probably been made, as contrasted with examinations of the meningeal fluid in which the demonstration of the organism is no doubt more likely to lead to a definite result. Considering, however, that in the meningeal fluid even negative findings are not unusual, it seems advisable in all doubtful cases to resort to blood examination also. Martini and Rohde's method should be tried, besides cultivation on blood serum, hydrocele agar and blood agar. My own observation I am inclined to view as a curiosity only and as not likely to be duplicated except on rare occasions. Nevertheless, a careful search should be made, which occasionally may lead to a fruitful result, and it is possible that by working with large drops of blood and Ross' dehemoglobinizing method positive findings may be more frequent.

Special Article

WATER SUPPLY AND PUBLIC HEALTH.

EDWIN O. JORDAN, Ph.D.
Professor of Bacteriology, University of Chicago.
CHICAGO.

(Concluded from page 1863.)

CHAPTER VII.

ARTIFICIAL METHODS OF WATER PURIFICATION.

(a) *House-Filters*.—The purification of water by artificial means as distinguished from natural or so-called self-purification may be accomplished in various ways. The use of domestic or house filters for this purpose has obtained wide extension, especially in countries where public water supplies are known to be impure. Some of the articles styled as filters or purifiers and sold as such have little value, and if they accomplish anything at all merely remove excessive color or turbidity from the water without materially increasing its safety. The principle underlying the operation of all of the better class of house filters is essentially the same, the actual straining out of the bacteria contained in the water. It needs no argument to show that only those filters made of exceedingly compact material can achieve the end desired. Through filters of loose or coarse material bacteria can pass freely without let or hindrance. Among the best known filters composed of compact material with fine pores through which the water is forced under pressure are the Pasteur-Chamberland and Berkefeld. Both of these types have been repeatedly demonstrated to be efficient when operated under the conditions obtaining in a bacteriologic laboratory, and it has been found that many of the cylindrical tubes of baked clay or of infusorial earth, when properly attached to a water tap, will continue to yield a nearly germ-free effluent for some days. It has been repeatedly demonstrated, however, that not all of the tubes put out by the manufacturers of even the best types of filters present an impassable barrier to the passage of bac-

teria. This is true even when the tubes are properly sterilized at the outset and are connected and handled with suitable precaution. A recent investigation by Pfuhl²³ has served to bring into sharp relief the impossibility of depending on an untested filter tube to furnish a germ-free filtrate. Phosphorescent vibrios and colon bacilli suspended in water appeared in the filtrate in a very short time in some of Pfuhl's tests. Great variation was noticed in the permeability of the different cylinders. A more vigorous application of suitable tests on the part of the manufacturers before allowing their tubes to be placed on the market would doubtless help to remedy this condition.

There is no doubt that a considerable, if varying, degree of safety is attained by the use of the best filters. Where such filters have been employed on a large scale, as in the well known case of the military garrisons in certain French cities, a decrease in typhoid fever among the filter users has been shown to occur. Few will question that where the small filters are controlled by bacteriologic tests and operated under careful supervision, they constitute a very efficient safeguard against water-borne disease. Under actual conditions in the household and elsewhere, the use of the best compact porous filters sometimes presents certain difficulties. The following quotation from a recent paper on military hygiene²⁴ illustrates this point: "It might be thought that nowadays most people understood the proper use of filters on the Pasteur principle;

Fig.—3.—This shows a section through a common type of mechanical filter. The cleansing of the sand is accomplished, at short intervals, by agitation with a revolving rake. The tank in the figure is about 12 ft. in diameter.

it has, however, been found that in regimental soda water factories in India (managed and supervised by regimental officers), where the water was known to be dangerous, and in need of efficient filtration, the filter bougies have been fixed in such a way as to permit of the water passing through the joint, instead of through the wall of the bougie; this being done in order to get a more rapid flow." The yield of these filters, particularly and necessarily those of the more efficient types, is always scanty, and if the details of connection and cleansing are entrusted to unskilful or negligent hands the proper operation of the filter may be rendered entirely futile. Not a little time and care are needed to insure that a battery of these tubes in a large school or factory is kept continually in efficient working order. Daily inspection of trustworthy and experienced persons is indispensable, and bacterial tests should be made at frequent intervals. The report on filters by a committee appointed by the French Academy of Medicine (1903)

7. Presse médicale, 1906, No. 6.

23. Festschr. f. R. Koch, 1903, p. 75.

24. Davies, Jour. of the Royal Army Med. Corps, 1904, 2, p. 706.