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SUMMARY OF FOUR YEARS OF CLINICAL AND BACTERIOLOGIC EXPERIENCE WITH MENINGITIS IN NEW YORK CITY *

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July 1, 1910, the preventive medicine annex of the Research Laboratory of the New York Board of Health took over the preparation, distribution and administration of antimeningitis serum from Rockefeller Institute. Jochmann, Kolle and Wassermann, the New York Board of Health and others had prepared the serum some time before it was taken up by Rockefeller Institute, so the serum itself was not new, but the credit for introducing its intraspinal use in this country is Dr. Flexner's. Under his direction, the Rockefeller Institute prepared it and distributed it to all who would supply careful records. This was of the greatest advantage in procuring a quick decision as to its great value. During part of the last big epidemic here (1904-05) the Health Department tried using it subcutaneously and found it to be of such doubtful value that its preparation was discontinued.

Meningitis is a reportable disease in New York City. The plan of the department from the first has been to have the physician on each case, so soon as he is known by the report of the case, offered the services of a department consultant.

We make our appointments with the attending physicians for the earliest moment possible and see cases nights and Sundays with them, because occasionally twelve hours' delay will seem to be a possible cause of a fatal outcome. We go over the history, examine the case, and if it seems to us to warrant it, even though we may not consider it to be one of meningitis, we do a lumbar puncture. It takes tact and infinite patience to persuade some of the poor, ignorant, foreign parents to allow us to do it, but usually if properly approached, they finally give in.

The conditions we have to consider mainly are epidemic or meningococcic meningitis, other purulent meningitides due most commonly in our experience to the streptococcus and pneumococcus and less

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commonly to the *Streptococcus mucosus capsulatus* and influenza, tuberculous meningitis, poliomyelitis and meningism, particularly in pneumonia. We see many other conditions, as our yearly tabulations will show — sufficient, indeed, to make our work pleasantly exciting, for when a case is reported the probabilities are that it is not going to be epidemic cerebrospinal meningitis.

As a general thing, we do not go to see patients in hospitals. At first we thought such cases received proper treatment and did not need us, but as our knowledge of meningitis has increased and we have from time to time had occasion to observe such treatment and the results, we think hospitals would be wise to call us in once in a while to instruct the house staffs, for they are often left pretty much to their own devices, and though the serum treatment of meningitis is beginning to find its way into text-books the busy attending physicians have not had much occasion to learn about it and have little advice to offer.

The points of differentiation in their order of value among the above named conditions are in general, lumbar puncture with the examination of the fluid, the history and the physical signs.

A clear fluid increased in amount indicates usually one of the following conditions: tuberculous meningitis, poliomyelitis, syphilitic involvement of the central nervous system, brain tumor or meningismus. A cloudy fluid is the result of a meningitis due to the meningococcus or some of the other pyogenic organisms.

In examining fluids, we make both bacteriologic and chemical studies and when these are not conclusive inoculate guinea-pigs. We make smears and cultures from the sediment if fluids contain any. Other fluids are centrifuged for one hour at high speed and the smear made by putting the last few drops from the tube onto a slide and evaporating to dryness in the incubator. Smears from cloudy fluids are stained by Gram's method, those from clear fluids with Ziehl's tubercle bacillus stain. Occasionally it is necessary to make a capsule stain. In examining the smears we note the presence or absence of bacteria and the number and kinds of cells.

We have never counted the cells for two reasons: first, it is some time usually between the time fluids are withdrawn and the time that they are examined, for most cases are at some distance from the laboratory; secondly, we see no great advantage in doing it. We can tell from the stained sediment whether the cells are increased much, little, or not at all, and there is nothing particularly diagnostic in the exact number of cells per cubic millimeter. Moreover, since in most cases the cells are very few in number and it is impossible to use a large amount of fluid, no method can be very accurate. In poliomyelitis at the stage at which we usually see it, and in tuberculous and syphilitic

meningitis, the cells are considerably increased, there being from 20 to 30 to a field. Mononuclears predominate up to 95 per cent. often. In epidemic cerebrospinal meningitis and the meningitides due to other pyogenic organisms the cells are enormously increased, so much so that it is not necessary to centrifuge. The polymorphonuclear leukocytes predominate, often up to 98 per cent. at first. Later, if the condition improves, the cells decrease and gradually the percentage of mononuclears increases.

The cultures are made after the smears are examined. Those showing *Streptococcus pyogenes*, *Streptococcus mucosus capsulatus* or meningococcus, or those in which no organism is found, but one of these is suspected of being the cause, are planted on 2 per cent. glucose ascitic agar. Those showing influenza or pneumococcus are planted on blood agar. Clear fluids are always injected subcutaneously in from 5 to 7 c.c. amounts into the groins of a guinea-pig. The pig is kept for a month and then injected in the axilla with 1 c.c. of crude tuberculin diluted to 3 c.c. with normal saline. Usually if it is tuberculous it is dead next morning. For proof of tuberculosis we depend on caseous inguineal glands or tubercles in the spleen or both at necropsy. Clear fluids that have become contaminated will sometimes produce enlarged inguinal glands that may even go on to caseation, but 1 c.c. of tuberculin will not kill in those cases.

We make chemical tests for albumin, globulin and reduction with Fehling's solution. For albumin, we use the nitric acid ring test and judge of the amount of albumin by the depth of the ring when it is first formed. The globulin test is that of Noguchi and is made by adding to one part of the fluid four or five parts of 10 per cent. butyric acid made up in normal saline, boiling, adding about as much normal sodium hydroxid as there was fluid to begin with and boiling again. Too much sodium hydroxid spoils the test by redissolving the globulin. Normal fluids will give a very faint opalescence; pathologic fluids a flocculent precipitate varying in amount with the severity of the inflammation present. Fluids showing globulin are said to be the result of inflammation of the meninges and we have never had reason to doubt it. Indeed, to us it is the most important of the chemical tests, because it separates fluids due to meningism from those due to a true meningeal infection. Both the albumin test and the globulin test are of course worthless, if there is blood present. The majority of clear fluids reduce Fehling's solution. The statement is now and then made that a differential point in diagnosis between tuberculous meningitis and poliomyelitis is the fact that poliomyelitis fluids will reduce Fehling's solution, but tuberculous fluids will not. We have tried Fehling's reaction with eighty-eight known tuberculous fluids and sixty-five, or 73 per

cent., gave good reduction. So, while the absence of reduction is of marked significance, the presence of reduction means absolutely nothing. The fluid from a case of heat prostration also failed to reduce Fehling's. In cloudy fluids it is not uncommon to find the reduction present if the case is seen early and is mild, then to go through a period where there is no reduction, and as the patient improves and the fluid clears, to have it return. In making the test we use equal quantities of Fehling's solution and spinal fluid.

We have examined two fluids and have seen a third that illustrated the syndrome of Froin. This is characterized by spontaneous coagulation and a yellow color. The pathogenesis of this condition is not known except, of course, that some hemorrhage has taken place. The two fluids we examined were from poliomyelitis patients, one of whom recovered and one died. The third fluid was from a patient with epidemic cerebrospinal meningitis supposed to have had a fracture of the skull. This patient recovered.

Table 1 is a concise statement of the various characteristics of the different fluids.

From July 1, 1910, to July 1, 1914, we examined 992 cerebrospinal fluids. Included with those we withdrew are some sent in by physicians who made their own punctures. Our method of examination and the differential points have already been discussed. We have found that examinations of fluids from epidemic cerebrospinal meningitis are more apt to be successful if done promptly, as the meningococcus sometimes autolyzes in twelve hours so that they will not grow and are very difficult to distinguish by smear. As cases recover the organisms are found more and more within the cells, and they usually show in spreads after the cultures become negative.

In examining for tubercle bacilli, we find the sediment after prolonged centrifuging at high speed better adapted to our purposes than the examination of the fibrin web. As our fluids are brought to the laboratory from varying distances, the formation of the web is disturbed; frequently, too, we wish to examine a fluid without allowing time for the web to form. By this method we get positive results in about 65 per cent. of cases. This is not nearly so high a percentage as that obtained by Dr. Hemingway at the Babies' Hospital using the web, but she was able to make several punctures, if necessary, while we rarely see a case of tuberculous meningitis more than once.

The history is of importance in the purulent meningitides, for, though they are differentiated from each other only by microscopical and cultural examinations, a history of middle-ear disease or fracture of the skull makes us suspect that some other than the meningococcus is the infecting organism. In differentiating between tuberculous

meningitis and poliomyelitis the history is of more importance than the examination of the spinal fluid if tubercle bacilli are not found, because the chemical and microscopic pictures are so frequently identical in the two conditions. In poliomyelitis there is usually the history of a sudden onset with a very high temperature dropping quickly. There may have been prodromata; gastro-intestinal disturbance is common, and many cases show redness of the throat or some involvement of the upper respiratory tract, but they are so slight that it takes careful questioning to elicit them. The history of a tuberculous case, on the other hand, is usually that of an insidious onset preceded by unusual irritability, though occasionally we see children in families in which they have been carefully observed that give a history of a sudden onset, frequently with convulsions. Usually the temperature has been between 99 and 101 F.; occasionally it will have been normal or subnormal. Transient paralyses, projectile vomiting and crying out in the night are frequently mentioned. Given a patient in apparent coma, usually a determined effort will rouse the child with poliomyelitis and he will answer intelligently, though afterward he sinks back immediately into stupor. It is impossible to rouse the tuberculous child in the stuporous stage.

The differentiation between epidemic cerebrospinal meningitis and tuberculous meningitis is usually comparatively easily made. Cases of epidemic cerebrospinal meningitis usually give a history of a sudden onset as against a slower onset in tuberculous meningitis. The patient's mental condition usually remains good in meningococcic meningitis unless it is a fulminating case. In tuberculous meningitis the history is commonly that of irritability followed by increasing stupor from which it is impossible to arouse the child. Patients with epidemic cerebrospinal meningitis show marked rigidity of the neck; tuberculous patients are apt to have slight or moderate anterior-posterior rigidity, but none laterally. In infants the rigidity of epidemic cerebrospinal meningitis is so easily overcome as to make one often doubt its existence, but when the infant is turned on the side the head is markedly retracted. The fever is higher in epidemic cerebrospinal meningitis, and runs an irregular course. Projectile vomiting is common in tuberculous meningitis and rare in epidemic meningitis.

Very few luetic or other chronic conditions of the central nervous system or meninges come to our attention, but we do see a good many cases of meningism. By meningism we mean that condition in which meningeal symptoms arise in the course of some disease, the cerebrospinal fluid being increased in amount but normal in character. Some difference of opinion exists in regard to the use of the term. It was introduced by Dupré, who considered it a functional disturbance.

Other writers have used the term serous meningitis, pseudomeningitis, meningitis sine meningitide and meningitis infectiosa circumscripta or circumscribed meningitis. This latter term is considered preferable by Plaut, Rehm and Schottmüller. Holt describes a case which showed at necropsy a circumscribed meningitis. Huber in an article on "Pneumococcus Meningitis and Meningism," inclines to the opinion that the pathologic basis is a localized inflammation, usually of infectious origin.

In the face of this evidence we cannot deny that cases exist in which the clinical picture and the increased fluid is due to a circumscribed infection, but from our experience it seems to us highly improbable that this is always or even often the case.

We have seen 80 cases of which the outcome in 53 was recovery and in 22 death, while with 5 the outcome is unknown. The diseases which the meningism accompanied are as follows:

Pneumonia—uncomplicated	39
Gastro-intestinal disease	8
Whooping-cough (two patients had pneumonia also)	6
Scarlet fever (one patient had pneumonia also)...	5
Typhus	3
Typhoid complicated by pneumonia	1
Measles	1
Middle-ear disease	1
Retropharyngeal abscess	1
Orbital abscess	1
Pott's disease	1
Epilepsy	1
Rachitis	1
Streptococcus osteomyelitis	1
Staphylococcus septicemia	1
Influenza	1
Nephritis	1
Heat prostration	1

Of the 22 patients who died, 8 died within twenty-four hours, and were desperately ill when seen. Of the 14 living longer than twenty-four hours, 4 died of pneumonia (in 1 two punctures were made with normal fluid in each instance), 1 of gastro-intestinal disease, 1 of whooping-cough complicated with bronchopneumonia, 3 of scarlet fever (1 complicated by bronchopneumonia and diphtheria, and 1 very septic), 1 of typhoid complicated by pneumonia, 1 of staphylococcus septicemia (two punctures done with normal fluid, one of streptococcus osteomyelitis—necropsy showed normal brain and meninges), 2, cause unknown.

In most of these cases the meningeal symptoms did not progress. Had they done so, a second puncture would have been made. In two cases, as noted, second punctures were done revealing normal fluids. In all cases the severity of the accompanying disease or diseases was quite sufficient to account for death. Of course, this by no means proves the absence of a localized meningeal infection. We have never

seen a case of generalized meningitis following a case of meningism, however, which we should expect to see occasionally considering the number under observation, were there a localized infection of the meninges, and in view of the relatively large number of patients that recover promptly, we believe that in most cases the condition is a functional one, probably of toxic origin.

In sixty-nine of these cases lumbar puncture was done. In the other cases we did not do a puncture, either because the symptoms had cleared up considerably when the case was seen or because with the accompanying disease we felt sure the case was one of meningism and advised waiting. Latterly, we have done a lumbar puncture even though we have felt sure it was meningism, as the withdrawal of the fluid seems to hasten recovery.

Of course, the amount of fluid depends on the stage of the condition at which the puncture is done. We have withdrawn very large amounts—from 80 to 100 c.c. In other cases the amount has been little increased above normal. It is commonly accepted that in a true meningitis the fluid is inflammatory in character—of the nature of an exudate. Such a fluid shows an increase in albumin and globulin and in the number of cells. In a meningism, as we use the term on the other hand, the fluid is of the nature of a transudate. Except in the cases noted below, the cells have not been increased, neither has the albumin and globulin content, and Fehling's has been readily reduced. In all cases they have been negative bacteriologically, by smear culture and animal inoculation.

In two cases of pertussis, the patients dying the same day the puncture was done, there was some increase in albumin and globulin and number of cells, in one case about equally divided between endothelial cells and polynuclears, in the other 95 per cent. or more polynuclears. These changes were presumably ante mortem. In one case of typhus the cells were increased—95 per cent. mononuclears. This patient recovered. The case of heat prostration showed a faint increase in albumin and a slight increase in cells, 70 per cent. being polynuclears. This fluid, as has been stated before, failed to reduce Fehling's, though repeated tests were made, and was the only fluid that did not do so readily. The patient recovered.

Plaut, Rehm and Schottmüller include under the term "meningism" cases with spinal fluid in which there is an increase in albumin and globulin and in number of cells usually mononuclear, sometimes polynuclear. We feel that such instances may be mild and recovering cases of epidemic cerebrospinal meningitis in which the organism has cleared up before the puncture was made. We have seen several cases ourselves in which from the clinical history, the progress of the case and

the character of the fluid we were convinced of the diagnosis, while we were unable to prove it bacteriologically.

In examining patients, we particularly note the following points: the presence or absence of MacEwen's sign or in infants a bulging fontanelle; the eyes (whether or not the pupils are dilated, contracted or unequal, presence of conjunctivitis, strabismus, nystagmus, etc.); the mental condition (whether there is delirium, irritability or stupor); the presence or absence of Kernig's and Brudzinski's signs; regularity in rate and depth of respiration and rate and volume of pulse; the reflexes (whether they are increased, diminished or absent); the temperature and presence or absence of an eruption. Of these signs we consider the stiffness of the neck, the variation of regularity in rate and

TABLE 1.—CHARACTERISTICS—

Meningeal Condition	Pressure	Amount c.c.	Appearance	Cytology
Normal	Normal	5-10	Clear	Very few cells
Meningismus	Increased	10-100	Clear	Very few cells
Poliomyelitis	Increased	20-100	Clear; sometimes slight fibrin web	Early polynucleosis; later lymphocytosis up to 95 per cent.; endothelial cells
Tuberculous meningitis	Increased	30-120	Clear fibrin web	Lymphocytosis up to 95 per cent.
Epidemic cerebrospinal meningitis	Increased	5-120	Cloudy	Polynucleosis up to 98 per cent.
Meningitis due to other organisms	Increased	20-100	Cloudy	Polynucleosis up to 98 per cent.

depth of respiration and MacEwen's and Brudzinski's signs the most important. MacEwen's sign consists of a change from the normal in the percussion note over the lateral ventricles due to increased intraventricular pressure. It takes some practice to appreciate it. Brudzinski's sign consists in the flexion and eversion of the legs and arms when an attempt is made to flex the head on the chest. Wherever we have found a MacEwen we have always obtained increased fluid, except in cases of basic meningitis, in which case the connection between the brain and cord is partially or totally cut off.

The mental condition is frequently good in epidemic cerebrospinal meningitis unless the case is of the fulminating type. Early in tuberculous meningitis there is irritability, later stupor. In poliomyelitis irritability not followed by stupor is the usual thing.

Conjunctivitis is fairly common in epidemic cerebrospinal meningitis and rare in other meningeal conditions. Ptosis and strabismus are

more common in tuberculous meningitis, but may occur in other meningeal conditions.

We do not attach much significance to Kernig's sign, because it is difficult to make sure of it in young children. Brudzinski's sign is of much greater value to our minds.

In true meningitis the depth and time between respirations is markedly irregular, the so-called Biot's breathing. Late, particularly in tuberculous meningitis, the respiration frequently becomes Cheyne-Stokes. The pulse is more apt to be irregular in rate and volume in tuberculous meningitis than in other meningeal conditions.

Palsies are uncommon in epidemic cerebrospinal meningitis; in 112 cases we have seen palsy twice only. It is common, but usually transi-

—OF THE VARIOUS FLUIDS

Bacteriology	Albumin	Globulin	Fehling's Solution	Animal Inoculation
Sterile	±	±	+	Negative
Sterile	±	±	+	Negative
Sterile	++-+++	++-+++	+	Negative
Tubercle bacilli	++-+++	++-+++	— in 25 per cent.	Tuberculosis in four weeks
Meningococcus	++-++++	++-++++	+ or — according to severity and stage	
Infecting organism	++-++++	++-++++	— may be + early	

tory in tuberculous meningitis, and always present in frank cases of poliomyelitis.

As has already been stated, the temperature in general is low and long continued in tuberculous meningitis, is high, rising rapidly and dropping quickly in poliomyelitis and runs a very irregular course in epidemic cerebrospinal meningitis.

Eruptions aside from herpes are not very common in our experience, though in times past epidemic cerebrospinal meningitis has been known as spotted fever. In 112 cases we have seen an eruption sixteen times. In cases in which it did occur there was nothing characteristic about the eruption itself, its location or the time of its appearance or disappearance.

Table 2 shows the number of cases from July 1 of one year to July 1 of the next year for the last four years.

The increase in numbers from year to year has been partly due to the gradual spread of the knowledge that such work is being done. We regret that even after four years there are many physicians in New York who are entirely unaware of the existence of our department. Aside from that, we feel that there has been a real increase in the number of cases of epidemic cerebrospinal meningitis. It is a disease for which apparently the majority of individuals have a natural immunity. Many healthy people carry meningococci in their noses and throats for long periods of time, acquiring them either from cases or from carriers. After a certain length of time, when there has been

TABLE 2.—NUMBER OF CASES BY YEARS, JULY 1, 1910, TO JULY 1, 1914*

	1910-1911	1911-1912	1912-1913	1913-1914	Total
Epidemic cerebrospinal meningitis	17	25	29	41	112
Tuberculous meningitis....	22	44	37	51	154
Other meningitides	11	7	11	18	47
Anterior poliomyelitis.....	1	25	16	5	47
Pneumonia	6	8	16	22	52
Other diseases	14	30	20	53	117
	<u>71</u>	<u>139</u>	<u>129</u>	<u>190</u>	<u>529</u>

* Some few of the cases during the first two years were seen only by Dr. Sophian, who had charge of the work during that time.

TABLE 3.—NUMBER OF CASES DURING THE FOUR QUARTERS OF THE YEAR

	July-October	October-January	January-April	April-June
1910-1911	..	5	3	9
1911-1912	6	4	10	5
1912-1913	4	6	9	10
1913-1914	2	4	16	19
	<u>12</u>	<u>19</u>	<u>38</u>	<u>43</u>

little meningitis about, a new generation of susceptible individuals comes on the scene. These, with possibly certain meteorologic factors which we do not understand, probably determine epidemics to a large extent. It has been about ten years since the beginning of the last epidemic. With the increasing number of cases another epidemic may be approaching. Fortunately, this last year it has been of a mild type.

Table 3 gives the number of cases during the four quarters of each year. The greatest number of cases occurs between March 1 and June 1 each year.

Table 4 shows the number of physicians with whom we have consulted and the number of cases we have seen with each.

There are 531 instead of 529 cases, because in two instances there were two physicians in charge of cases, and in order to make the number of physicians come out right it was necessary to count each of these cases as two.

TABLE 4.—PHYSICIANS CONSULTED AND CASES SEEN

Physicians	No. of Cases Seen with Each	No. of Cases Seen
254	1	254
60	2	120
10	3	30
8	4	32
8	5	40
4	6	24
1	7	7
3	8	24
<hr/> 348		<hr/> 531

The treatment of epidemic cerebrospinal meningitis resolves itself into prophylaxis and specific and general treatment. The prophylaxis consists in quarantining patients ill with the disease and those in contact with them who show meningococci in cultures from the nose and throat. Under ordinary circumstances epidemic meningitis is not very highly contagious, but it sometimes becomes so. We have seen more than one case in a family in only four instances. The first time a child of 11 had it and three months later her mother had it. Both recovered. The second time two brothers, adults, were sick in the same room. Most insanitary conditions prevailed. The first brother had been ill two weeks and had had no doctor. The second was a fulminating case and the patient died in three days. The first one was sent to a hospital and finally died after five weeks' illness. In the third instance, a brother and sister, adults, and the 8-year-old daughter of the sister were all ill in the same apartment. The brother and sister were taken ill within two hours of each other and both died. The little girl was taken five days later and recovered. The day before the little girl was taken sick a neighbor, a man living in the same house came down with it and eventually recovered. The fourth instance was that of a sister of 14 and a brother of 3½. The sister had been taken sick two days before the boy. The attacks were mild and both recovered.

The question of carriers is rather a difficult one. In the first place, it requires careful bacteriologic technic to isolate meningococci from nose and throat cultures when they are few in numbers, and the work cannot be left to laboratory assistants unless they have exceptional training. When there are many cases to be diagnosed and treated is the time when nose and throat cultures from carriers come in thick and fast, and until quite recently we have not had a sufficiently large force to manage the cultures satisfactorily. From some work done here two years ago, we think the most satisfactory method of dealing with carriers is to swab out the nose and throat two or three times daily with 20 per cent. argyrol. We hope to do more work along this line this winter. Hatchel and Hayward report success with a spray of anti-meningococcic serum and with subcutaneous injections of meningococcus vaccine.

The specific treatment consists in the intraspinal administration of antimeningitis serum. This is a specific immune serum of therapeutic value only in meningococcic meningitis and then only when administered subdurally. In making a lumbar puncture we do not use either general or local anesthesia. We think that general anesthesia is dangerous, and local anesthesia takes so much preparation and time that the overcoming of the pain does not compensate for the increased nervous tension on the part of the patient. Adults not acutely ill who submit to lumbar puncture for diagnostic purposes do not seem to mind much. The back is not very sensitive, and if the patient is held properly—lying on the side with the knees drawn up against the abdomen, the neck bent and the back well arched so that the intervertebral spaces will be as great as possible—and the operator is skilful there is very little pain. Never under any circumstances do we do it with the patient sitting up. Iodin is used over about 4 square inches immediately around the point of election for puncture and a sterile or bichlorid towel is laid over the hips through which to find the landmarks. We have never to our knowledge had a secondary infection of the meninges of the cord. Sometimes the skin has become infected in small children from soiled napkins. We use a Quincke needle size 18 or 19, and go in the mid-line through the notch most nearly coinciding with a line drawn from crest to crest of the ilium. A piece of tubing about 15 inches long is attached to the metal connection that fits in the end of the needle when the stylet is withdrawn. To the other end of the rubber tubing is attached the barrel of a syringe. We usually cut the rubber and insert a short piece of glass tubing near the metal connection so that we can see the fluid flowing out or the serum flowing in. It is well to attach the tubing in removing the fluid because by raising and lowering the glass container the

rapidity of outflow can be regulated. A too sudden decrease in intracerebral pressure is undesirable. When the fluid withdrawn is cloudy we always inject antimeningitis serum at once even though we suspect that some other organism may be the cause. The serum does no harm no matter what the organism may be, and if it is meningococcic meningitis the earlier serum is administered the better. Later treatment depends on the examination of the cerebrospinal fluid. We have used streptococcus and pneumococcus serums in appropriate cases. No patient with pneumococcus meningitis directly under our supervision has recovered, but we know of two patients who did. One patient with streptococcus meningitis out of fifteen recovered, but no influenzal patient. At present we have a good supply of anti-influenzal serum furnished us by Dr. Flexner, and as cases come along we shall use it.

As stated above, if the first fluid is cloudy we inject antimeningitis serum. It is warmed to body temperature and injected very slowly by gravity under the least possible pressure. This method was introduced by Koplik. A syringe is dangerous, and is probably responsible for many deaths following the administration of serum. In general, the dose for an adult is from 20 to 40 c.c., and for infants and children from 3 to 20 c.c. The amount depends as much on the quantity of cerebrospinal fluid withdrawn as on the age. An infant will frequently stand 20 c.c. without difficulty. The dose should usually be at least 5 or 10 c.c. less than the amount of cerebrospinal fluid withdrawn.

We have seen a number of cases of undoubted dry taps during the course of cases of meningococci meningitis. The serum ran in freely and showed the usual variation in movement depending on respiration. In such cases it is advisable to proceed very slowly and to watch the patient carefully for the slightest change in pulse and respiration. We think that possibly in some cases the exudative period is followed for a short time by one of decreased secretion. At any rate, a dry tap is frequently followed by one in which fluid is obtained. In cases with thick exudate that will not flow through the needle, gentle suction with a syringe may be tried. If that fails a little serum injected will sometimes start the flow. In very severe cases we inject the serum every twelve hours until there is improvement. In moderate and mild cases we usually repeat it each day for the first four days. Further administration depends on the patient's general condition and the bacteriologic examination of the fluid. Usually from 4 to 6 injections are necessary, but we have employed as many as sixteen or more. We consider that we get better results if the patient is turned from side to side so that no two successive punctures are done with the patient lying on the same side. That insures the emptying of the lateral ventricles in rotation.

A number of times during or immediately after the injection of serum the patient has gone into shock. Respiration has become slow and shallow or ceased, the facies pale and pinched and the pulse rapid and thready. At first this was very alarming, but we have never had a patient die from it. If the needle is still in place we withdraw some of the serum. Artificial respiration is resorted to if breathing has ceased and hypodermic stimulation is given for the heart. We have seen it happen much less frequently since we have been using smaller doses.

The serum we have been using lately contains 0.2 per cent. trikresol; earlier it contained 0.3 per cent. As is well known, the trikresol has been blamed by several physicians, especially Dr. Kramer of Cincinnati, for the fatal results that have been reported in a few instances following the injection of antimeningitis serum, usually in young children. Hale, of the Hygienic Laboratory at Washington, and Auer, of Rockefeller Institute, report experiments with dogs showing that serum containing trikresol is somewhat more toxic than unpreserved serum or that containing chloroform or ether. Auer carried on experiments with monkeys also, and showed that they were far less sensitive to trikresol serum than the dogs. Furthermore, in France, where serum without preservative is used, cases of shock and occasional fatal results are reported. As stated above, we have never seen such a case, although we have administered the serum considerably over five hundred times and to children of all ages, fourteen of our patients being under a year old. In view of our experience with serum that has always contained trikresol, we cannot believe that it is the cause of the fatalities. We think rather, that they may be due to injudicious administration of the serum — too large doses, or too rapid increase of pressure, which is likely to happen unless the gravity method is used — or to an unusual susceptibility on the part of the patient. On account of the fear of trikresol — unfounded, we feel — that has been produced by these reports, it seems advisable to try for a while the use of chloroform or a preservative. A comparison of the results with the serum prepared with the two different preservatives will enable us to decide which method is preferable.

We have not given the method of administering serum with the use of the blood-pressure apparatus a fair trial because we have so seldom had sufficient assistance to manage it. We think it is probably a help to those who have had little experience.

If a case shows a tendency to become chronic we make an autogenous vaccine and give it every four or five days in doses of from 250 to 1,000 million. Sometimes it has seemed to be very effective, but we have not had enough cases to be able to draw definite conclusions. We can say that we have never seen it do any harm. In treating cases it

must be remembered that frequently the stiff neck is the last symptom to disappear and if the fluid has cleared up and the temperature stays down it may be entirely disregarded.

The use of hexamethylenamin (urotropin) comes between general and specific treatment. We recommend its administration in all acute meningeal infections. It is said that twenty minutes after its administration formaldehyd can be detected in the spinal fluid. It may not be there in sufficient amounts to do much good, but the procedure seems rational. The fact that meningococci may be isolated from the urine is another argument for its use. In one case of *Streptococcus mucosus capsulatus* meningitis we gave hexamethylenamin dissolved in normal saline intraspinally. The temperature dropped from 106 F. to 102 F., and the patient became rational, but the case terminated fatally.

In planning the general treatment we find it necessary to remember that epidemic cerebrospinal meningitis may be a greatly prolonged febrile disease. The patient is best kept in a quiet darkened room. Sedatives are needed if the patient is very restless. We have had one fatal prolonged case in which we thought the patient might have been saved had the doctor given her an opiate so that she might occasionally have had a few hours of rest. The bowels and bladder should receive careful attention, particularly the bladder. Retention and cystitis are not uncommon. The patient should be examined for a distended bladder daily and the family warned to report infrequency of micturition. Patients should not lie in a draught and should be carefully covered up, especially during and after puncture. We have learned by bitter experience how easily they fall victims to pneumonia. In ordering the hygiene of the sick-room it must be remembered that the meningococci are found in the secretions of the nose and throat and in the urine. The diet should be such that it may be easily digested but generous in amount. The high caloric diet of typhoid is indicated for the reason that meningitis-like typhoid may be prolonged. The ice-bag gives a measure of relief for the headache.

Among the complications we have had:

Pneumonia in	7 cases
Basic meningitis in	6 cases
Paralysis in	3 cases
Hydrocephalus in	3 cases
Deafness in	3 cases
Cystitis in	2 cases
Serum rash in	2 cases
Iritis in	2 cases
Typhoid in	1 case
Scarlet fever in.....	1 case
Measles in	1 case
Purulent otitis media in.....	1 case
Blindness in	1 case
Arthritis in	1 case

In no case of basic meningitis under our care has recovery ever ensued. At first we used to try very hard to get the patients into hospitals to have brain puncture done. Now we explain to the family that it may do some good, but do not urge it strongly because we do not feel that it is of much avail. Of the cases with paralyses, two cleared up. One case of deafness cleared up entirely after the lapse of several months. The patients with typhoid and measles both recovered. We are much interested in the question of mental deterioration following meningitis and are following up our cured patients. In the course of time we shall have sufficient data from which to draw conclusions.

Table 5 shows our mortality statistics for the four years from July 1, 1910 to July 1, 1914.

TABLE 5.—MORTALITY, JULY 1, 1910, TO JULY 1, 1914

Year	Total No. Cases	Patients Recovered	Patients Died	Result Unknown	Mortality Per Cent.
1910-1911	17	10	7	0	41
1911-1912	25	7	15	3	60
1912-1913	29	17	12	0	41
1913-1914	41	30	11	0	26

The 1911-1912 statistics need some explanation: four cases developed into basic meningitis and in five other fatal cases the patients were either in hospitals already or were sent there and we had slight oversight of the treatment.

We feel that this particular department — meningitis — is a worthwhile venture in treating cases of meningitis, in teaching physicians whom we see in consultation to administer serum and in training a group of experts who will be able to handle efficiently the outbreaks of meningitis that occur about every ten years in New York City.