THE INTRAVENOUS SERUM TREATMENT OF EPIDEMIC CEREBROSPINAL MENINGITIS

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The meningeal aspect of meningococcus infections has usurped such a prominent place in the commonly accepted ideas of the nature of epidemic cerebrospinal meningitis, that important facts have been kept in the background. The very name of the disease and the causative agent have given undue prominence to a single manifestation of a condition that in our opinion is very much more than a cerebrospinal meningitis. This is by no means a new idea. Others have from time to time expressed the opinion that meningococcus infections are primarily septic in nature and that meningitis is a secondary complication. So far as we are aware, however, this conception has not been adopted as a practical working basis for diagnosis or treatment. Such prominence has been given the meningitis that the premeningitic stage of meningococcus sepsis has been for practical purposes disregarded. It is our view that in a recognition of this primary stage of sepsis lies the key to early diagnosis and a more effective treatment.

This point of view has been forced on us by experience of an epidemic of 208 cases in the Base Hospital, Camp Jackson, and has been reached more or less independently by workers at the bedside and workers in the laboratory. The practical results have been the recognition of primary meningococcus sepsis in almost half of the cases before the characteristic selective action on the meninges has been exerted; the recognition of abortive cases or of other types of meningococcus sepsis not showing meningitis, the establishment of intravenous serum therapy on a firm basis with notable reduction of mortality and, further, the development of clinical and laboratory methods of diagnosis of proved value.

In making this report and in publishing conclusions that are at variance with some existing views we wish to make clear that much of this study was made under what were practically field conditions, in a hospital in the stage of organization, often without heat or even water, with inadequate ward and laboratory equipment and an overworked staff. Under these conditions in a certain number of the cases laboratory confirmation of the clinical diagnosis could not be had. We fully realize that an absence of finesse possible in civil conditions may

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well be a source of criticism of certain parts of our work and we wish publication made with that understanding.

Meningitis is a medical emergency. On prompt recognition and vigorous action the life or future wellbeing of the victim depends more than in almost any other acute disease. In order to insure early diagnosis, Lieut. Col. Kent Nelson, Division Surgeon, 81st Division, instructed the regimental surgeons to refer at once to the Base Hospital all men complaining of headache, fever, vomiting or other suggestive symptoms. Thus an incomparable opportunity for study of the early stages of these and other acute diseases was offered.

Symptoms and Signs.—Meningitis is preceded by a stage showing symptoms and signs of a generalized infection. This stage lasts from a few hours to three days—averaging about forty-eight hours. A few patients with this meningococcus sepsis never develop meningitis. These are usually either the abortive or the fulminating cases, rarely those with prolonged course. Recognition of the stage of sepsis depends on two kinds of evidence: (1) clinical, (2) bacteriologic. Approximately one half of our cases were recognized in the premeningitic stage. The clinical evidence of the incipient disease is, to the practiced observer, fairly definite, although for certainty laboratory confirmation is usually necessary. Description of the early symptoms or signs follows.

The fever is rarely above 102 F.—more often 99 to 101. The pulse is relatively slow, with frequent vagal irregularities. There is a characteristic attitude, manner and facies. The patient is not exactly irritable, but is resisting, prefers to be let alone and lies on his side with thighs and knees drawn up, shielding his face with the coverings. He is very sensitive to cold and resents exposure. The responses are intelligent, but are given in as few words as possible and with the least effort. The voice is not modulated; the muscles of expression are not brought into play. The voice and expression are "far away." There is a vacant look of apathy and dulness that is almost constant. The veins of the temporal region and forehead are full, the eyeballs are tender, and cyanosis of the face is most common. This is especially noticeable in the margins of the ears which are purplish in the region of the helix, antihelix and lingula, often with a sharp line of demarcation. The pupils are almost always dilated. A few cases show slight retinal edema with faint obscuration of the disk margins and fulness of the retinal veins.

In a large proportion of the cases there is an upper respiratory tract infection, a coryza, pharyngitis, tonsillitis, laryngitis; rarely bronchitis; in four cases a pneumonia. This respiratory involvement is so noticeable that it is more than a coincidence and demands careful

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study. This was noted in our preliminary report,[1] also by Medlar,[2] Mink,[3] Thomsen and Wulff.[4] The oral secretions are often viscid in the extreme, the tongue coated, the breath heavy.

The skin manifestations are most important. Early there may be a more or less diffuse mottling, giving a lead-colored appearance. *Tâche cérébrale* is constant but of slight value in diagnosis. A few cases, mostly of the milder type, have shown a macular rash resembling early chickenpox or large rose spots. This rash is often very puzzling and characterizes the less severe types. The predominant skin sign is the petechial rash. This appears about the shoulder or pelvic girdle if at all; next in order of frequency, over the trunk, extremities, face, oral mucosa, and conjunctiva. We have not observed it in the retina. It appears with astonishing rapidity in crops, and in some of the severe cases the patient may become well dotted within an hour. The individual spots are typically petechial, the larger are raised above the skin surface, do not disappear on pressure, vary in size up to 1 cm. in diameter and last about three days, leaving a pigmented stain. In the presence of an epidemic, such a rapidly developing hemorrhagic rash is diagnostic. Purpura is a feature of the fulminating cases. This purpura does not arise from the petechial spots, but is a separate lesion. It develops with the greatest rapidity, and within a few hours considerable areas of the body surface may be covered.

Next to the rash, the reflexes give the most valuable early evidence of the disease. In a word, there is an unequal enhancement of the deep reflexes. The epigastrics, the knee jerks, the Achilles jerks, all tend to be exaggerated, with inequality. In a study of the deep reflexes of the early stages of acute disease in our receiving ward, such increased reflex irritability is found to be common in a variety of infections. This increase, however, is uniform on both sides of the body. The feature of the altered reflex irritability of meningococcus infection is the lack of uniformity of corresponding reflexes on both sides. One case began with a picture resembling that of an acute articular rheumatism; another with that of an acute, purulent meningococcus conjunctivitis. Slight chills are common. Headache is present in about 85 per cent. of the cases. It is frontal or vertical, less often lower occipital, may be most severe, and is described as a sense of unbearable pressure or "bursting." It is important to note

1. Herrick, W. W.: Epidemic of Meningitis at Camp Jackson, Jour. Am. Med. Assn., 1918, **70,** 227.

2. Medlar, E. M.: Epidemic Cerebrospinal Meningitis at Camp McClellan, Jour. Am. Med. Assn., 1918, **70,** 458.

3. Mink, C. J.: Points in the Epidemiology of Meningitis; abstr., Jour. Am. Med. Assn., 1916, **66,** 463.

4. Thomsen, O., and Wulff, F.: Meningococcus Infection and Meningitis, Hospitalstidende, 1917, **60,** 1192; abstr., Jour. Am. Med. Assn., 1918, **70,** 498.

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that rigid neck, Kernig, and Brudzinski are almost always absent during this stage.

The clinical suspicion aroused by any combination of two or more of the signs or symptoms enumerated demands lumbar puncture. In the stage of sepsis, the spinal fluid is usually clear, shows in about 60 per cent. of the cases a slight increase in pressure, a normal number of cells, reduces Fehling's solution, and may or may not show a trace of globulin. Examination after long centrifugation and the evaporation on the slide of several cubic centimeters of the residue remaining after pouring off the supernatant fluid generally reveals one or more pairs of meningococci, almost always extracellular and variable in form and size. As noted in our preliminary report,[1] repetition of lumbar puncture within a short time often results in bringing down the organisms which, in our opinion, are first present in the cerebral-intraspinal spaces and find their way into the lower spinal spaces only after lapse of several hours. By special methods recently published[5] Capt. F. W. Baeslack, chief of the laboratory, has found meningococci by blood culture in this early stage in 36 per cent. of the cases so examined.

Clinical types of meningococcus sepsis. — Four types may be described — the abortive or atypical, the ordinary, the severe, the fulminating.

The abortive types: These are mild systemic disturbances without local focus of suppuration. Many of these patients have symptoms and signs of meningeal irritation. They may present themselves with headache and vomiting, may show a stiff neck, a positive Kernig and increased reflexes, slight fever and evidence of infection of the upper respiratory tract. They do not have the rash. The spinal fluid may be under increased pressure, but shows no abnormal elements and generally no meningococci. The diagnosis depends on the clinical picture and the demonstration of the meningococcus in the spinal fluid, nasopharynx, conjunctivae or blood stream. One of these patients who had evidence of meningismus showed an extraordinary high agglutinin titer of the blood. The brevity of the duration of these cases is surprising. Within twenty-four hours most of them are well; rarely they remain in bed forty-eight hours. Their importance is naturally epidemiologic. Doubtless in a large epidemic many such cases are undiscovered, being passed over as harmless, upper respiratory tract or other infections. They are, therefore, a great menace to susceptible contacts. They prove the importance of careful study of every case showing fever and any minor disturbances during the presence of an epidemic. The atypical cases are of peculiar interest and will be made the subject of a special report. One of these took

5. Baeslack, F. W.; Bunce, A. H.; Brunelle, G. C.; Fleming, J. S.; Klugh, G. F.; McLean, E. H.; Salomon, A. V.: Cultivation of the Meningococcus Intracellularis (Weichselbaum) from the Blood, Jour. Am. Med. Assn., 1918, **70,** 684.

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the form of a subacute polyarthritis with positive blood culture, a somewhat prolonged course and a prompt response to large doses of serum intravenously. Recovery was complete.

The ordinary type: In these cases the symptoms of the generalized infection usually last thirty-six to seventy-two hours. They are as a rule, mild, the rash is usually slight and may be petechial or macular, never diffusely purpuric. The evidence of meningitis develops gradually; unconsciousness is rare, and the course may be prolonged. The chief emphasis is on the meninges. These cases show the typical headache, stiff neck, positive Kernig and Brudzinski signs; altered reflexes, irritability and the purulent spinal fluid. Hydrocephalus is a considerable danger and the response to intravenous serum therapy is often less prompt than in the more severe types.

The severe type: The stage of sepsis usually lasts from eight to forty-eight hours, during which there is evidence of severe toxemia. Patients are depressed, uncommunicative and wish to be left alone. The upper respiratory tract infection is frequent, with a viscid condition of the oral secretions. Fever is rarely above 102 F. The feature of these cases is the petechial rash, which appears with the startling rapidity described. The patient is profoundly prostrated, and, as a rule, becomes unconscious before any evidence of secondary suppurative foci in the meninges or elsewhere can develop. Polyarthritis is common in these serious types. Death may occur before any such metastases arise. Response to intravenous serum treatment is, as a rule, prompt. The most brilliant results with this method are in these grave cases. Few therapeutic experiences are so immediately satisfactory. The patients often rouse from coma, the rash and other symptoms rapidly recede and within forty-eight hours many are apparently out of danger. Intraspinous serum administration alone is usually insufficient to check their downward progress. Diagnosis in the premeningitic stage is usually possible. The blood culture is generally positive.

Fulminating cases: These are tragic in the extreme. The patient is overwhelmed with a toxemia and may die within a few hours. One of our patients lived only four hours after onset of symptoms. Another who suffered with a "cold" for three days went to bed at night with slight malaise and was found dead by his fellows early the next morning. These patients have a temperature of from 102 to 104 F.; a rapid pulse, vomiting, delirium, the petechial rash, and, most characteristic of all, extensive purpura. As a rule meningitis is not present. Clinical evidence, which may or may not be definite, is readily confirmed by blood culture or by demonstration of meningococci in the spinal fluid. In some cases the spinal fluid obtained by lumbar puncture shortly before death has been negative, while that obtained from the lateral ventricles immediately after death has shown meningococci.

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This emphasizes the importance of our recommendation that lumbar puncture be repeated in doubtful cases to bring down the organisms for diagnostic purposes.

The complications.—The manifold complications of this epidemic have constituted a strong argument in favor of the view that the disease is primarily a sepsis. The purulent character of many of these cases is important. After the symptoms of the generalized disease subside such complications may continue to act as a nidus of infection from which relapses may arise or a general toxemia result, retarding or preventing recovery. Proper surgical or serum treatment of such a focus is of the greatest importance. Nine patients had panophthalmitis. The infection reaches the eyes through the ciliary vessels, not the optic nerve sheaths. The cornea becomes congested, the iris cloudy. Soon the media become opaque, and within a few hours sight is lost. The rapidity with which the entire organ is invaded and destroyed is a strong argument for the view that the infection is hematogenous. Fortunately, but one of our patients suffered a bilateral panophthalmitis. Enucleation has been performed in most of our cases with great improvement in the general condition of the patient. The affected eye is a source of pain, of mental and nervous irritability and other evidence of toxemia. On microscopic examination these eyes show meningococci in astonishingly large numbers. Optic neuritis and retinitis are present in some degree in a large number of cases and are of value in early diagnosis. Paralysis of the extrinsic muscles of the eye, most often those supplied by the sixth nerve, has been noted in six cases. One of these was bilateral, five were transitory.

We have observed but one case of endocarditis. This patient developed a relapse with dilated heart, a loud systolic murmur over the precordium, symptoms of sepsis and a positive blood culture. At necropsy a few small fresh vegetations were found on the tricuspid valve. The myocardium seems to suffer little. The pulse rate is slow during the early stages, often rapid during convalescence. There were six cases of dry fibrinous pericarditis. One of these at necropsy showed the most extensive possible deposit of fibrin in masses, some 5 cm. in diameter, over the visceral and parietal layers. Two cases exhibited pericardial effusion as a late complication. One patient had a temperature ranging to 104 F. One hundred and ten c.c. of bloody purulent fluid were removed, showing meningococci in pure culture; 30 c.c. of meningococcus antiserum were injected into the pericardial sac with prompt relief of symptoms and disappearance of meningococci in the fluid subsequently aspirated. Separate report will be made of these pericardial complications.

Pulmonary lesions are not at all uncommon. Three patients showed at onset consolidation of part or all of a lower lobe; one a small pleural effusion from which meningococci were grown.

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Arthritis has been quite a feature of the epidemic. One case began as an apparent acute articular rheumatism; in two the arthritis preceded the meningitis, in others this complication appeared late. Arthritis in the stage of sepsis, is usually very painful, involves many joints, is not accompanied by much swelling or effusion, but shows local redness, heat and tenderness. The picture is almost exactly that of acute rheumatic polyarthritis, but is more transitory. The arthritis of the last stage is more generally monarticular, most often involving the knee, is purulent, accompanied by great swelling, but shows little redness and is only moderately painful. It is striking that despite the presence of a large purulent exudate in knee joints in the late stage of meningococcus sepsis, there is little muscular spasm or limitation of motion on account of pain. Repeatedly the meningococcus has been grown from the pus obtained in these joints. Serum has frequently been injected directly into the knee joints with apparent benefit. The prognosis of meningococcus arthritis, although a feature of the severe cases, is good and permanent disability is rare.

Otitis media has been common; none has required mastoid operation. At necropsy, the accessory sinuses of the nose are frequently found filled with pus which in a few instances contained meningococci. There have been three cases of monoplegia. Nine cases have shown epididymitis or orchitis. This has not been suppurative and has subsided in a few days without apparent atrophy. The postmeningitis cachexia is notable, although infrequent after intravenous therapy. There is emaciation, a waxy pallor of the skin, anemia, irritability, apathy, weakness and vertigo, tachycardia, exaggerated reflexes. In this condition it is of the highest importance to make a thorough physical examination. Often one of the complications enumerated above is discovered. Again, nothing can be found. Usually such patients recover after a prolonged period.

Two cases have relapsed; one four weeks after convalescence, another, three weeks. The second attack may be more severe than the first. A special report of these relapsing cases will be made. The fact of their occurrence lends discouragement to vaccine prophylaxis and other measures for the production of immunity.

A matter of highest importance is the recognition that epidemic cerebrospinal meningitis often occurs during the course of other acute diseases. The meningococcus seems to flourish in a soil prepared by any organism or by any condition that will lower the general bodily tone. A large number of our cases have developed during the acute stages or shortly after measles, pneumonia, otitis media, tonsillitis, or other infections of the respiratory tract. This association deserves special emphasis. Meningococcus infections as a complication of other acute diseases gives a confused clinical picture in many instances.

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The diagnosis here naturally depends almost entirely on the laboratory. The clinical acumen must furnish the initial suspicion. The change of condition, the fatigue of travel, of unaccustomed drill, homesickness and other new influences to which the recruit is subjected doubtless act in a manner similar to acute diseases in paving the way for meningococcus infections.

Necropsy findings.—Among the fifty-four deaths in this series of 208 cases, thirty-one necropsies were performed. Owing to an overwhelming amount of clinical work and limited equipment, it was impossible to examine all of the dead. There was a remarkable dryness of the bodies. Section of the muscles resulted in little or none of the oozing usually seen. The peritoneum was often lustreless because of this lack of moisture. The lungs in many cases were dry and shrunken. The liver, spleen and kidneys, while enlarged in many instances, lacked the ordinary amount of fluid. This dehydration explains the excessive thirst of so many patients and is the basis of our routine ward order that water be offered every fifteen minutes to those awake.

Captain Blakeslèe in several cases demonstrated that the exudate was subarachnoid and not immediately subdural. He has been unable to find necropsy evidence of suppuration about the cribriform plate of the ethmoid. In none of our cases did the macroscopic appearance suggest extension of the process from this point.

The following is a summary of the findings: Lack of lustre of the meninges without exudate, 1; purulent exudate in the central nervous system, 26; exudate localized in the vertex alone, 7; in the base alone, 3; vertex and base, 16; in the lateral ventricles, 10; parietal region alone, 5; occipital region or cerebellum alone, 0; congestion of meninges without exudate, 5; adhesion of meninges to cortex, 6; blocking of foramen magnum or ventricles, 6. The choroid plexus was in most cases congested and in more than half the number cystic. Eleven showed petechiae in the skin; 10, purpura. Diffuse purpura was not seen in the serous membranes, viscera or muscles. One case having athetoid and convulsive movements of the left side before death showed a large hemorrhage in the right Rolandic area with multiple small hemorrhages throughout the subcortical areas of cerebrum and cerebellum. Petechiae are frequent on both visceral and parietal surfaces of the pericardium and peritoneum. Four had conjunctival petechiae. Heart hypertrophy, 1; dilatation, 1; acute vegetative endocarditis (tricuspid), 1; pericarditis, fibrino-purulent, 4; sero-purulent, 4. Pleurisy was present in 8; lobar pneumonia in 2; bronchopneumonia in 8; lung congestion in 7; abscess in 1. The spleen was enlarged in 22 cases, normal in size 4; in 5 it was not examined. Kidney: cloudy swelling, 10; congestion, 10. Adrenal congestion, 1.

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Liver, enlarged and congested, 17; showing cloudy swelling and fatty change in 5. Peritonitis, 1. Suppurative choroiditis, 3.

Treatment.—Based on the conception that the disease is in its early stages a generalized meningococcus sepsis which can be recognized before meningitis or other complications develop, the serum treatment, as established by Jochmann, Flexner and others has undergone modification at our hands. Instead of attacking a metastatic focus of infection in the meninges, we have sought to reach the organism during the stage of systemic invasion by intravenous serum therapy. This measure was at first tried as one of desperation in an attempt to save the life of a member of the staff of the Base Hospital who was stricken with a serious type of the disease. Success led us gradually to develop the present method. Having no standard criteria of such treatment, we have felt our way gradually until, with an experience of over 100 patients treated intravenously, we believe that a safe and satisfactory method has been worked out. Not only does clinical observation seem to justify the method to be described, but statistical study of cases treated by various methods shows that with the newer forms of treatment there is a decrease in mortality. Treatment in this epidemic has passed through three phases; the first phase, of intraspinal therapy alone; the second, of intraspinal combined with timid intravenous therapy; the third, of bold intravenous treatment combined with liberal drainage of the spinal fluid and the use of a considerable, though as a rule, a small amount of serum intrathecally.

On admission a patient presenting a combination of the early symptoms mentioned is subjected to lumbar puncture. If the spinal fluid is cloudy, enough is removed to reduce the intraspinal pressure to an approximate normal and a less amount of serum is at once allowed to run into the spinal canal. If the spinal fluid is clear, no intraspinal injection is made. The fluid is rushed to the laboratory in a thermos container and immediately examined. Meanwhile the patient receives a desensitizing dose to determine sensitiveness. One hour later 50 to 120 c.c. are administered by vein, the first 15 c.c. at the rate of 1 c.c. per minute. Large glass syringes are best for this, as the flow is easily controlled and a cumbersome arrangement of tubes and stopcocks is not necessary. In a case of ordinary severity this intravenous dose is repeated every twelve hours until the temperature becomes normal, or until six or eight injections have been given. In severe cases the serum is repeated every eight hours until the desired results are obtained. In fact, the size and frequency of intravenous serum doses is very like those advised by the group of workers in the Rockefeller Institute in lobar pneumonia of the appropriate type.

We have seen no ill effects from these large amounts of meningococcus antiserum. In a retrospect of the epidemic, our regrets are that

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so many cases received doses too small. If given at all by vein, the serum must be boldly used. Study of Class B cases would seem to show that small amounts may have even a harmful effect. It is our belief, however, that this is not the case. In a few cases the temperature is seemingly not influenced by the intravenous injections. In such the type of serum is changed, an interval of about forty-eight hours is allowed to elapse and another series of doses given. So soon as meningitis develops the usual intraspinal injections are given and repeated about once in twenty-four hours for a varying number of days until the organisms disappear from the spinal fluid and lymphocytes make their appearance in numbers. With large intravenous injections of serum the meningococci, as a rule, disappear from the fluid within twenty-four to forty-eight hours and repeated intraspinal serum administration is not deemed necessary. The greater our experience in intravenous serum therapy in this disease, the more have we attempted sterilization of the blood by massive doses of serum, particularly in the early stages when the positive blood culture and the clinical picture indicate a generalized hematogenous infection. When meningitis is established, this treatment is supplemented by repeated spinal drainage, puncture usually being done about half an hour after the intravenous injection. Serum is introduced into the spine in amount sufficient to relieve the severe headache which may follow such drainage. It is our idea that by thus draining the spinal canal considerable antibody may escape from the blood stream into the upper intraspinal spaces through the choroid plexus. Experimental and clinical study of this point is in progress.

It is possible to overdo treatment. Some of the more prolonged cases, even when meningococci persist in the spinal fluid, do better or even recover promptly when all treatment is stopped. This is especially true of the cases that have little fever and in which the serum seems to act as an irritant giving rise to headache, delirium and increased opisthotonus. Other treatment is not neglected. Second in importance to serum is morphin, which should be freely used, especially in the early stages. Chloral and bromid are of minor help in controlling symptoms. Nervous patients are given opiates, with or without chloroform, before puncture is made. No patient is forcibly restrained during puncture. Large amounts of fluid and liberal nourishment are provided.

Table 1 shows that the total mortality of the entire series of 208 cases is 26 per cent. In the 129 cases treated by intraspinal methods alone or with intravenous serum doses of 10 to 45 c.c., it is 31.7 per cent.; in 79 treated by larger amounts of serum intravenously and average or smaller amounts intrathecally, 16.4 per cent. The mild cases do well by either method of treatment. It is in the severe types that the intravenous methods give the most striking results. Sixty-two

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TABLE 1.—EPIDEMIC CEREBROSPINAL MENINGITIS

March 4, 1918. 208 Cases

Class	Cases	Deaths	Mortality, per Cent.
A1a	36	1	2.7
A1b	17	0	0.0
A2a	15	12	80.0
A2b	24	12	50.0
A	92	25	27.0
B1a	7	0	0.0
B1b	5	0	0.0
B2a	5	2	40.0
B2b	20	14	70.0
B	37	16	43.2
A and B	129	41	31.7
C1a	11	1	9.9
C1b	4	0	0.0
C2a	17	2	11.3
C2b	47	10	21.1
C	79	13	16.4
A, B and C	208	54	26.0

KEY TO TABLE

Class A: Cases having intraspinal serotherapy alone.

Class B: Cases having the usual intraspinal serotherapy and small amounts (10 c.c. to 45 c.c.) of serum intravenously.

Class C: Cases treated with large amounts of serum intravenously with average or small amounts intraspinally.

1. Mild cases.
2. Severe cases.

a. Cases with early diagnosis (recognized before the spinal fluid became cloudy).
b. Cases with later diagnosis (recognized after the spinal fluid became couldy).

and five-tenths per cent. of the serious cases in Classes A and B died; 18.5 per cent. of corresponding types in Class C. Another important effect of intravenous therapy is the apparent reduction in number of complications; 31 per cent. of Class A and B cases showed important complications; 14 per cent. of Class C.

It may be argued that Class C cases were those from the later stages of the epidemic when the meningococcus might have lost some of its virulence and that the results of intravenous serotherapy are therefore, not better than might have been reached with older methods. The possibility is admitted, but is not considered by us a probability. Clinically the cases studied in the later phases of the epidemic seemed about as severe as those seen earlier. One of the last of our deaths was a fulminating case with purpura.

Table 2 shows certain facts of interest. It is, however, misleading in that the Class C cases would appear to have received the most active

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intraspinal treatment. It is to be borne in mind that report is made of the development of a method rather than of the method itself. This development extended throughout four months of a large epidemic and a sharp line of separation between various phases of this development is not possible. The tables do not, therefore, nor do the descriptions, represent the final method adopted or its results. In a future publication it is planned to take this up in detail. Table 2 is proof that intraspinal treatment has not been neglected, but it does not correctly indicate the amount of serum given by vein or spine in the fully developed combined method. In order to avoid too detailed classification we have arbitrarily placed every case receiving more than 50 c.c. of serum by vein in Class C. Most of our patients are now given from 200 to 600 c.c. by vein and a lesser average amount intraspinally than the table indicates. It is important to note the shorter period of fever and the earlier average disappearance of meningococci from the spinal fluid in Class C. It is a common experience to have organisms disappear from the spinal fluid after the first or second massive intravenous serum injection. The laboratory workers made special remark of this fact when such treatment began to be used freely.

TABLE 2.—SUMMARY OF CLASSES A, B AND C

Class	Average Number Spinal Punctures	Average Amount Spinal Fluid Out, C.c.	Average Amount Serum in Spine, C.c.	Average Amount Serum in Veins, C.c.	Average Duration of Fever, Days	Average Duration of Meningococci in Spinal Fluid, Days
A and B	4.6	180.2	110.5	38	9	5.5
C	7.2	279.5	138.4	151	7.3	3.1

Ventricular puncture was not done. The rapidity with which formation of spinal fluid occurs makes a single puncture of one ventricle rather futile. The anatomic situation found at necropsy bears out this impression. The effect can be but brief and the operation is one of some magnitude. First Lieut. S. A. Cobb, M. R. C., has devised a method of starting the flow in cases in which it is impossible to secure more than a few drops of thick fluid in patients beginning to show signs of blocking of foramina. Chloroform is given, relaxing spasm of the neck muscles. Lumbar puncture is then done and the head manipulated with the idea of breaking up adhesions that may be forming about the foramen magnum and floor of the fourth ventricle. Necropsy study has shown that it is possible to achieve appreciable mobility of the region. The method is often successful in starting the flow and in one instance brought about resumption of respiration when this function had ceased. In this case life was apparently saved. Liberal drainage in the cases with prolonged course, and the use of Lieu-

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KEY TO TABULATION OF MENINGITIS CASES IN TABLE 3

Class A: Cases having intraspinal serotherapy alone.

Class B: Cases having the usual intraspinal serotherapy and small amounts, 10 c.c. to 45 c.c. of serum intravenously.

Class C: Cases treated with large amounts of serum intravenously with average or small amounts intraspinally.

1. Mild cases.

2. Severe cases.

a. Cases with early diagnosis (recognized before the spinal fluid became cloudy).

b. Cases with late diagnosis (recognized after the spinal fluid became cloudy).

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TABLE 3.—DATA OF 208 CASES—

Class	No.	Name	Duration of Fever, Days	Developing During or After				Symptoms During Onset and Course of Disease																No. Showing Important Comp.			
				A. Pneumonia	B. Mumps	C. Measles	D. Others	1. Headache	2. Nausea	3. Vomiting	4. Chills	5. Delirium	6. Convulsions	7. Fever, F.	8. Pulse	9. Arthritis	10. Coryza	11. Sorethroat	12. Pneumonia	13. Cough	14. Unconsciousness	15. Eruption	16. Backache	A. Panophthalmitis	B. Arthritis, Mono.	B. Arthritis, Poly.	C. Paralysis, elsewhere
A1a	1	Clary	18	..	..	..	Otitis R	+	..	+	..	..	..	105.3	136	..	+	+	..	..	..	..	..	..	..	..	..
	2	Grubb	6	..	..	..	..	+	..	..	..	..	..	99.2	80	..	..	..	..	..	..	..	..	..	..	..	..
	3	Hickey	9	..	..	..	..	+	..	+	..	..	..	100.2	100	..	..	..	..	..	..	..	+	..	..	..	..
	4	Hunter	6	..	..	..	..	+	+	+	..	..	..	101.0	116	..	..	..	..	..	..	+	..	..	..	..	..
	5	Hooks	13	..	..	..	..	+	+	+	+	..	..	99.6	84	+	..	..	..	..	..	+	..	..	..	..	..
	6	Hendrix	9	..	..	..	Otitis R	+	..	..	..	..	..	100.0	78	..	Nystagmus					..	..	..	..	..	..
	7	Hawkins	8	..	..	..	..	+	..	..	+	..	..	102.0	126	..	..	..	..	..	..	+	+	..	..	..	..
	8	Wall	0	..	..	..	..	F+	..	..	..	..	..	98.2	100	..	..	..	..	..	..	..	..	..	..	..	..
	9	Wood	3	..	..	..	..	F+	..	..	..	..	..	102.4	122	..	..	..	..	..	..	..	+	..	..	..	..
	10	Couch	1	..	..	+	..	F+	..	+	..	..	..	104.0	116	..	..	..	..	..	..	..	+	..	..	..	..
	11	Harris	72*	+	+	+	..	..	..	..	+	..	..	98.0	78	..	..	..	..	..	..	..	..	..	..	+	..
	12	Watkins	9	..	..	..	..	+	..	+	..	..	..	98.0	74	..	..	..	..	..	..	..	+	..	..	..	..
	13	Allen	0	..	..	..	..	+	..	+	..	..	..	99.2	90	..	..	..	..	..	..	..	..	..	..	..	..
	14	Epes	2	..	..	..	..	0+	..	..	..	..	..	100.2	80	..	..	..	..	..	..	..	+	..	..	..	..
	15	Green	7	+	..	+	..	..	..	..	..	..	..	101.0	100	..	+	+	..	..	..	..	+	..	..	..	Deltoid
	16	Smith	2	..	..	..	..	+	..	..	..	..	..	96.0	100	..	..	..	..	..	..	..	..	..	..	..	..
	17	Cone	2	..	..	..	..	F+	..	..	+	..	..	101.0	102	..	..	+	..	..	..	..	..	..	..	+	..
	18	Crook	8	..	..	..	..	..	..	..	+	..	..	102.8	83	..	..	..	..	..	..	..	..	..	..	+	..
	19	Marler	4	..	..	..	..	+	..	+	+	..	..	100.3	102	..	..	..	..	..	..	..	..	..	..	..	..
	20	McNamara	9	..	..	..	Tonsillitis	..	..	..	..	..	..	97.4	98	..	..	+	..	..	..	..	..	..	..	..	..
	21	Davis	6	..	..	..	..	F+	..	+	..	..	..	102.0	106	..	..	..	..	..	+	..	..	..	..	..	..
	22	Moser	0	..	..	+	..	..	..	..	..	..	..	97.0	72	..	..	..	..	..	..	+	..	..	..	..	..
	23	Bethea	4	..	..	..	..	F+	..	..	..	..	..	100.2	98	..	..	+	..	..	..	+	..	..	..	..	..
	24	Ponds	6	..	..	+	..	+	..	..	..	..	..	99.0	86	..	..	..	..	..	..	+	..	..	..	..	..
	25	Blue	4	..	..	..	..	F+	..	..	..	..	..	105.0	96	..	..	..	..	..	..	..	+	..	..	..	..
	26	Reynolds	2	..	..	..	..	..	..	+	..	..	..	98.0	94	..	..	+	..	..	..	..	..	..	..	..	..
	27	Seiff	14	..	+	..	..	0+	..	..	..	..	..	97.0	72	..	..	..	..	..	+	..	..	..	..	..	..
	28	Moody	23	..	..	..	..	..	..	..	+	..	..	100.0	92	..	..	..	..	..	..	..	+	..	..	..	..
	29	Delameter	5	..	..	..	..	+	+	+	+	..	..	101.8	72	..	..	..	..	..	..	..	..	..	..	..	..
	30	Armfield	2	..	..	..	..	F+	..	..	+	..	..	102.8	76	..	..	..	..	..	..	..	..	..	..	..	..
	31	Marlam	9	..	..	..	..	+	..	..	..	..	..	103.0	108	..	..	..	..	..	..	..	..	..	..	..	..
	32	Williams	3	..	..	..	..	F+	..	..	+	..	..	101.2	100	..	..	..	+	..	..	..	..	..	..	..	..
	33	Turner	12	..	..	..	Tonsillitis	+	..	..	..	..	..	104.0	110	..	..	+	..	..	..	..	..	..	..	..	..
	34	Guiley	9	..	..	+	..	F+	..	..	..	..	..	98.4	64	..	..	..	..	..	..	..	..	..	..	..	..
	35	Larke	0	..	..	..	..	+	..	..	..	..	..	98.8	72	..	..	..	..	..	..	..	..	..	..	..	..
	36	Lohse	2	..	..	..	..	..	..	..	..	..	..	103.1	102	..	..	..	..	..	..	..	..	..	..	..	..
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		Average	6	..	..	..	..	..	..	..	..	..	..	101.0	90												
A1b	1	Bowden	2	..	..	+	+	F+	+	..	..	..	..	101.4	96	..	..	..	..	..	..	+	+	..	..	..	..
	2	Tilley	21*	..	..	..	..	0+	+	+	..	..	..	99.6	84	..	..	..	..	..	..	..	..	..	..	..	..
	3	Taylor	13	..	..	+	..	0+	+	..	+	..	..	108.0	92	..	..	..	..	..	..	+	..	..	..	..	..
	4	Thorn	4	..	+	..	..	F+	..	..	..	..	..	100.0	90	..	..	..	..	..	..	+	..	..	..	..	..
	5	Graham	5	..	..	..	..	F+	..	+	+	..	..	101.2	72	..	..	..	..	..	..	..	..	..	..	..	..
	6	Rose	1	..	+	..	..	+	+	..	..	..	..	102.0	92	..	..	..	..	..	..	+	..	..	..	..	..
	7	Bass	5	..	..	..	..	+	..	+	..	..	..	100.4	90	..	..	..	..	..	..	..	..	..	..	..	..
	8	Warrenfells	3	..	..	..	..	+	..	+	+	..	..	100.4	90	..	..	..	..	..	..	..	..	..	..	..	..
	9	Feezell	4	..	..	..	..	+	..	+	+	+	+	97.0	90	..	..	..	..	..	..	+	..	..	..	..	..
	10	Harrelson	3	..	..	..	..	+	..	+	..	..	..	103.0	100	..	..	..	..	..	..	..	+	..	..	..	..
	11	Mitchell	9	..	..	..	..	+	..	..	+	..	..	100.4	72	..	..	..	..	..	..	+	+	..	..	..	..
	12	Burton	27	..	..	+	..	+	..	+	..	..	..	100.2	90	..	..	..	..	..	..	..	..	..	..	..	..
	13	Crowell	4	..	..	+	..	+	..	+	..	..	..	100.4	88	..	..	..	..	..	..	..	..	..	..	..	..
	14	Lail	0	..	..	..	..	+	..	..	..	..	..	98.0	76	..	..	..	..	..	+	+	..	..	..	..	..
	15	Garland	2	..	+	..	..	F+	..	..	..	..	..	100.2	92	..	..	..	..	..	..	..	..	..	..	..	..
	16	Slayton	3	..	..	..	..	+	..	..	..	..	..	98.0	78	..	..	..	..	..	..	+	..	..	..	..	..
	17	Boyd	1	..	..	+	..	+	..	..	..	..	..	97.4	74	..	..	+	..	..	..	+	..	..	..	..	..
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Reflexes: N means normal; + means exaggerated; ++ means hyperactive; +++ means very hyperactive; R>L means right greater than left; 0 means absent.
* Other cause for fever.

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—OF CEREBROSPINAL MENINGITIS

Number Showing Important Complications								Serum Effects									Reflexes (On Admittance)											Misc.	
								Anaphylaxis			Rashes			Adenitis															
C. Paralysis, Ocular	D. Epididymitis	E. Pneumonia	F. Pleurisy	G. Pericarditis, Dry	G. Pericarditis, Fluid	H. Otitis Media	I. Others	Chill	Collapse	Dyspnea	Erythema	Urticaria	Other Rashes	Cervical	Inguinal	Epitrochlear	General	Neck Rigidity	Kernig	Brudzinski	Patellars	Achilles	Abdominal	Cremasteric	Biceps	Triceps	Babinski	Clonus	Photophobia	Herpes
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TABLE 3.—DATA OF 208 CASES OF—

Class	No.	Name	Duration of Fever, Days	Developing During or After: A. Pneumonia	B. Mumps	C. Measles	D. Others	Symptoms During Onset and Course of Disease: 1. Headache	2. Nausea	3. Vomiting	4. Chills	5. Delirium	6. Convulsions	7. Fever, F.	8. Pulse	9. Arthritis	10. Coryza	11. Sorethroat	12. Pneumonia	13. Cough	14. Unconsciousness	15. Eruption	16. Backache	No. Showing Important Comp.: A. Panophthalmitis	B. Arthritis, Mono.	B. Arthritis, Poly.	C. Paralysis, elsewhere
A2a	1	Williams	9	..	..	..	.....	....	..	..	..	..	..	100.3	68	..	Lat. nystag.						+	..	..	..	.....
	2	Lynn	14	..	+	..	.....	+	..	..	..	+	..	98.0	96	..	..	..	..	+	+	..	..	..	..	..	.....
	3	Clinton	D	..	..	..	.....	....	..	..	..	..	..	97.4	74	..	..	..	..	..	..	..	..	..	..	..	.....
	4	Skelton	2D	..	..	..	.....	+	..	..	..	..	..	102.0	94	..	+	..	..	..	+	+	..	..	..	..	.....
	5	Ellis	D	..	..	..	.....	+	..	..	..	..	..	107.0	156	..	..	..	..	..	+	+	+	..	..	..	.....
	6	Murphy	D	..	..	+	.....	+	..	..	..	..	..	101.0	120	..	..	..	..	..	+	+	..	..	..	..	.....
	7	Sells	D	..	..	+	.....	+	..	..	..	..	..	103.0	70	..	..	+	..	..	..	..	+	..	..	..	.....
	8	Evans	D	..	..	+	.....	F+	..	..	..	+	..	100.3	80	..	..	..	..	..	..	..	+	+	..	..	.....
	9	Packs	D	..	..	..	.....	F+	..	..	..	+	..	103.2	100	..	..	..	..	+	+	+	+	..	..	..	.....
	10	Westfield	3	..	..	..	.....	+	..	+	+	..	..	102.0	92	..	..	..	..	..	+	+	..	..	..	..	.....
	11	Frost	D	..	..	+	.....	+	..	..	..	..	..	99.2	84	..	+	..	..	+	..	..	+	..	..	..	.....
	12	Hill	D	..	..	+	.....	....	..	..	..	..	..	100.0	84	..	..	..	..	+	..	..	..	..	..	..	.....
	13	Buchanan	D	..	..	..	.....	....	..	..	..	+	..	104.2	104	..	..	+	..	..	+	+	..	..	..	..	.....
	14	Meyers	D	..	..	..	.....	F+	..	+	+	..	..	102.4	104	..	..	..	..	..	..	..	..	..	..	..	.....
	15	Bean	D	..	..	..	.....	....	..	..	..	+	..	103.4	100	..	Purpura				+	+	+	..	..	..	.....
		Total	..	0	1	5	0	10	0	2	2	5	0	.....	...	0	2	2	0	4	8	7	7	1	0	0	0
		Average	9	..	..	..	.....	....	..	..	..	..	..	102.5	95	..											
A2b	1	Rich	19	..	..	..	.....	....	..	..	..	+	..	98.0	100	..	..	..	..	..	+	+	..	..	..	..	.....
	2	Melden	D	..	..	..	.....	....	..	..	..	+	..	100.2	92	..	..	..	..	..	+	+	..	..	..	..	Facial
	3	Cochran	13	..	..	..	.....	+	..	..	..	..	+	96.8	98	..	..	..	..	..	..	..	..	..	..	+	+
	4	Sullivan	40*	..	..	..	Tonsillitis	+	+	+	+	..	..	99.0	86	..	..	..	..	..	+	..	..	+	..	..	.....
	5	McMillan	19	..	..	..	.....	F+	..	+	..	..	..	99.2	112	..	..	..	..	..	+	+	..	..	..	..	.....
	6	Cook	42*	..	..	..	.....	F+	+	+	+	..	..	101.0	100	..	..	..	..	..	+	+	..	..	..	+	.....
	7	Smith	1	..	..	..	.....	+	..	..	+	+	..	98.0	64	..	+	..	..	..	..	..	..	..	..	..	.....
	8	Thomas	9	..	..	..	.....	+	..	..	..	..	..	98.6	104	..	..	..	..	..	..	..	..	..	..	..	.....
	9	Farrell	5	..	+	..	.....	....	..	+	..	+	..	99.4	84	..	..	..	..	..	+	..	..	..	..	..	.....
	10	Port	47D	..	..	..	.....	+	..	..	..	..	..	103.2	108	..	..	..	..	+	..	..	..	..	..	..	.....
	11	Weathers	4D	..	..	..	.....	....	..	..	..	..	..	100.8	68	..	..	..	..	..	+	..	..	..	..	..	.....
	12	Lee	D	..	..	..	.....	+	..	..	..	..	..	103.0	104	..	..	..	..	..	..	..	+	..	..	..	.....
	13	Greener	D	..	..	+	.....	+	..	..	..	..	..	101.0	100	..	..	..	+	..	..	+	..	..	..	..	.....
	14	Gibson	3	..	..	..	.....	0+	..	..	+	+	..	100.0	100	..	..	..	..	..	..	..	..	..	..	..	.....
	15	Moseley	D	..	..	..	.....	F+	..	..	..	..	..	98.0	100	..	..	..	..	..	..	+	..	..	..	..	.....
	16	Harmage	D	..	..	..	.....	....	..	..	..	..	..	102.5	104	..	..	..	..	..	..	..	..	..	..	..	.....
	17	Page	D	..	..	+	.....	+	..	..	..	..	..	98.2	106	..	..	..	..	+	..	..	..	..	..	..	.....
	18	Josey	4	..	..	+	.....	+	..	+	+	..	..	101.2	90	..	..	+	..	+	+	+	+	..	..	..	.....
	19	Ward	D	..	..	+	.....	+	..	..	..	..	..	103.6	100	..	..	..	+	+	+	..	..	..	..	..	.....
	20	Denson	D	..	..	..	.....	+	..	+	..	+	+	98.8	100	..	..	..	..	..	+	+	..	+	..	..	.....
	21	Sumner	D	..	..	..	.....	+	..	..	..	+	+	99.8	104	..	..	..	..	..	..	..	..	..	..	..	.....
	22	Fringer	23	..	..	..	.....	+	..	..	..	..	..	101.6	76	..	..	..	..	..	..	+	..	..	..	+	.....
	23	Matthews	?	..	..	..	.....	0+	+	..	..	..	..	99.0	80	..	..	..	..	..	..	..	..	..	..	..	.....
	24	Womack	14	..	..	..	.....	+	..	+	..	..	..	100.8	88	..	..	..	..	..	..	..	+	+	..	..	.....
		Total	..	0	1	4	1	19	3	7	5	7	3	.....	...	0	1	1	2	4	10	9	3	3	0	3	1
		Average	9	..	..	..	.....	....	..	..	..	..	..	100.0	100												
B1a	1	Grisson	3	..	..	+	.....	+	..	..	..	..	..	98.0	72	..	..	..	..	+	..	+	..	..	..	..	.....
	2	Fletcher	2	..	+	..	.....	F+	..	+	..	..	..	103.0	94	..	..	..	..	..	..	+	..	..	..	..	.....
	3	Pierce	5	..	..	+	.....	+	..	+	..	..	..	104.0	110	..	..	..	..	+	..	..	..	..	..	..	.....
	4	Crews	15	..	..	..	.....	+	..	+	+	..	..	102.0	116	..	..	..	..	..	..	+	..	+	..	..	.....
	5	Williamson	3	..	..	..	.....	....	..	..	..	..	..	98.0	76	..	..	..	..	..	..	..	+	..	+	..	.....
	6	Pennington	5	..	..	..	.....	F+	..	+	..	..	..	98.8	84	..	..	+	..	+	..	..	..	..	..	..	.....
	7	Smith	2	..	..	..	.....	F+	+	..	..	..	..	102.0	120	..	..	..	..	..	..	..	..	..	..	..	.....
		Total	..	0	1	2	0	6	1	4	1	0	0	.....	...	0	0	1	0	3	0	3	1	1	1	0	0
		Average	4	..	..	..	.....	....	..	..	..	..	..	102.0	100												

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—CEREBROSPINAL MENINGITIS—(*Continued*)

Number Showing Important Complications								Serum Effects										Reflexes (On Admittance)											Misc.	
								Anaphylaxis			Rashes			Adenitis																
C. Paralysis, Ocular	D. Epididymitis	E. Pneumonia	F. Pleurisy	G. Pericarditis, Dry	G. Pericarditis, Fluid	H. Otitis Media	I. Others	Chill	Collapse	Dyspnea	Erythema	Urticaria	Other Rashes	Cervical	Inguinal	Epitrochlear	General	Neck Rigidity	Kernig	Brudzinski	Patellars	Achilles	Abdominal	Cremasteric	Biceps	Triceps	Babinski	Clonus	Photophobia	Herpes
Swelling optic disks																		++	++	....	++	....	++	++	R>L++	R>L	R>L	0	..	..
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..	..	..	..	..	..	..												++	++	+	++	....	0	0	....	....	....	..	..	..
Choroidal abscess																		+	+	+	++	+	R>L	R>L	+	+	L	0	..	..
..	..	..	..	..	..	+												+	+	+	R	R	N	N	++	+++	0	0	..	..
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Unequal pupils L>R																		....	....	....	0	++	....	....	....	....	0	R	..	..
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Edema of disks																		+	+	....	++	....	....	....	....	....	....	..	..	..
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TABLE 3.—DATA OF 208 CASES OF—

Class	No.	Name	Duration of Fever, Days	Developing During or After				Symptoms During Onset and Course of Disease																	No. Showing Important Comp.			
				A. Pneumonia	B. Mumps	C. Measles	D. Others	1. Headache	2. Nausea	3. Vomiting	4. Chills	5. Delirium	6. Convulsions	7. Fever, F.	8. Pulse	9. Arthritis	10. Coryza	11. Sorethroat	12. Pneumonia	13. Cough	14. Unconsciousness	15. Eruption	16. Backache	A. Panophthalmitis	B. Arthritis, Mono.	B. Arthritis, Poly.	C. Paralysis, elsewhere
B1b	1	Buzzard	5	..	..	..	.....	F+	..	..	..	..	..	101.2	108	..	..	..	..	..	..	..	+	..	..	..	.....
	2	Letchworth	9	..	..	..	.....	+	+	+	+	..	..	97.0	80	..	..	..	..	..	..	..	..	..	..	..	.....
	3	Brademeyer	7	..	..	..	.....	F+	..	+	+	..	..	102.0	100	..	..	..	..	..	..	..	..	..	..	..	.....
	4	Millwood	3	..	..	..	.....	F+	..	+	..	..	..	101.0	118	..	..	..	..	..	..	+	..	..	..	..	.....
	5	Stillwell	4	..	..	..	.....	+	..	+	..	..	..	98.6	99	..	..	..	..	..	..	+	..	..	+	..	.....
		Total	..	0	0	0	0	5	1	4	2	0	0	.....	...	0	0	0	0	0	0	2	1	0	1	0	0
		Average	5	..	..	..	.....	....	..	..	..	..	..	101.0	100												
	1	Manley	21	..	..	..	.....	....	..	..	..	..	..	99.6	120	..	..	..	..	..	..	..	..	..	..	..	.....
	2	Grubb	4	..	..	..	.....	+	..	..	..	..	..	99.0	80	..	..	..	..	..	..	..	..	..	..	..	.....
	3	Spurlock	8	..	..	..	.....	+	+	+	..	..	..	101.0	100	..	+	+	..	..	..	..	..	..	..	..	.....
	4	Packer	0	..	..	..	.....	F+	..	..	..	..	..	99.0	66	..	+	..	..	..	..	..	..	..	..	..	.....
	5	Dukes	D	..	..	..	.....	....	..	..	+	..	..	100.4	104	..	..	+	..	+	..	..	..	..	..	..	.....
		Total	..	0	0	0	0	3	1	1	1	0	0	.....	...	0	2	2	0	1	0	0	0	0	0	0	0
		Average	10	..	..	..	.....	....	..	..	..	..	..	100.0	100												
B2b	1	Wetmore	19	..	..	..	.....	+	..	..	..	+	..	101.2	100	..	..	..	..	..	..	+	..	..	+	..	.....
	2	Blanchard	12	..	..	..	.....	+	..	..	..	..	..	101.0	98	..	..	..	..	+	..	..	..	+	..	..	.....
	3	Coulter	14	..	..	..	.....	+	+	+	..	..	..	99.2	68	..	..	..	..	..	+	..	+	..	..	..	.....
	4	Shafner	27	..	..	..	.....	+	..	..	+	..	..	102.2	82	..	..	..	..	..	+	..	..	+	..	..	.....
	5	Benner	D	..	..	..	.....	+	..	+	+	..	..	100.2	64	..	..	..	..	..	..	..	..	..	..	..	.....
	6	Murphy	D	..	..	..	.....	+	..	..	..	..	..	101.8	110	..	+	..	..	..	..	+	+	..	..	..	.....
	7	Pope	D	..	..	..	.....	....	..	+	+	..	..	101.8	100	..	..	..	..	..	..	+	+	..	..	..	.....
	8	Borden	19	..	..	..	.....	+	..	+	..	..	..	98.2	88	..	..	..	..	..	+	+	..	..	..	..	.....
	9	Poole	D	..	..	..	.....	....	..	..	..	..	..	101.0	96	..	..	..	..	..	+	..	..	..	..	..	.....
	10	Thomas	1	..	+	..	.....	....	..	..	..	..	..	103.0	96	..	..	+	..	..	..	+	..	..	..	..	.....
	11	Dyer	D	..	..	..	.....	+	..	+	..	..	..	101.4	102	..	..	+	..	..	..	..	+	..	..	..	.....
	12	Beasley	16	..	..	..	.....	F+	..	+	..	..	..	97.4	84	..	..	..	..	..	+	..	..	..	..	..	.....
	13	Tanner	D	..	..	..	.....	....	..	..	..	+	..	103.0	110	..	..	..	..	..	+	..	..	..	..	..	.....
	14	Smith	D	..	..	..	.....	+	..	..	+	..	..	101.0	88	..	+	+	..	+	..	..	+	..	..	..	.....
	15	Chandler	D	..	..	..	.....	....	..	..	..	..	..	98.2	88	..	..	..	..	+	+	+	..	..	..	..	.....
	16	Culpepper	D	..	..	..	.....	F+	..	..	..	..	..	98.6	84	..	..	..	..	..	+	+	..	..	..	..	.....
	17	Anderson	D	..	..	+	.....	....	..	..	..	..	..	100.0	100	..	..	..	..	..	..	..	..	..	..	..	.....
	18	White	D	..	..	..	.....	F+	..	..	+	..	..	99.0	82	..	..	..	..	..	..	+	+	..	..	..	.....
	19	Castles	D	..	..	..	.....	....	..	..	..	..	..	100.0	100	..	..	..	..	..	+	+	..	..	..	..	.....
	20	Adams	D	..	..	..	.....	....	..	..	..	..	..	103.0	?	..	..	..	..	..	+	+	..	..	..	..	.....
		Total	.....	0	1	1	0	12	1	6	5	2	0	.....	...	0	2	3	0	3	10	10	6	2	1	0	0
		Average	10	..	..	..	.....	....	..	..	..	..	..	99.0	90												
C1a	1	Fleming	2	..	..	..	.....	+	..	..	+	..	..	100.2	104	..	..	..	..	..	..	+	..	..	..	..	.....
	2	Latham	5	..	..	..	.....	....	..	..	..	..	..	98.0	80	..	+	..	..	+	..	+	..	..	..	..	.....
	3	Davis	7	+	..	..	.....	....	..	..	..	..	..	101.0	98	..	..	..	..	..	+	..	..	..	..	..	.....
	4	Hilner	4	..	..	..	.....	0+	..	..	..	..	..	100.0	126	..	..	+	..	..	..	..	..	..	..	..	.....
	5	Staley	8	..	..	..	.....	+	+	+	+	..	..	101.2	80	..	..	..	..	..	..	..	..	..	..	..	.....
	6	Layton	3	..	..	..	.....	+	..	..	..	..	..	98.2	76	..	..	..	..	..	..	..	..	..	..	..	.....
	7	Moore	6	..	..	..	.....	T+	..	+	+	..	..	100.8	96	..	..	..	..	..	..	..	..	..	..	..	.....
	8	Thacker	15	..	..	+	.....	+	..	..	..	..	..	100.4	74	..	..	..	..	..	..	+	..	..	..	..	Facial, left arm
	9	Galloway	6	..	..	..	.....	+	..	..	..	..	..	101.0	110	..	..	..	..	..	..	+	+	..	..	..	.....
	10	Bray	4	..	..	..	.....	F+	..	+	+	..	..	100.4	112	..	..	..	..	..	..	+	..	..	..	..	.....
		Total	.....	1	0	1	0	8	1	3	4	0	0	.....	...	0	1	1	0	1	1	5	1	0	0	0	1
		Average	6	..	..	..	.....	....	..	..	..	..	..	100.5	100												
C1b	1	Breaux	19	..	..	..	.....	F+	..	..	+	..	..	99.4	128	..	..	..	..	..	+	+	+	..	..	..	.....
	2	Carkhuff	4	..	..	..	.....	+	+	+	..	..	..	101.0	120	..	..	..	..	..	..	..	..	..	..	..	.....
	3	Arrants	3	..	..	..	.....	+	+	+	+	..	..	100.2	88	..	..	..	..	..	..	..	..	..	..	..	.....
	4	Fletcher	14	..	..	..	.....	+	..	+	..	..	..	103.0	94	..	..	..	..	..	+	..	..	..	..	..	.....
		Total	.....	0	0	0	0	4	2	3	2	0	0	.....	...	0	0	0	0	0	2	1	1	0	0	0	0
		Average	10	..	..	..	.....	....	..	..	..	..	..	101.0	100												

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Number Showing Important Complications									Serum Effects									Reflexes (On Admittance)											Misc.	
									Anaphylaxis			Rashes			Adenitis															
C. Paralysis, Ocular	D. Epididymitis	E. Pneumonia	F. Pleurisy	G. Pericarditis, Dry	G. Pericarditis, Fluid	H. Otitis Media	I. Others		Chill	Collapse	Dyspnea	Erythema	Urticaria	Other Rashes	General	Epitrochlear	Inguinal	Cervical	Neck Rigidity	Kernig	Brudzinski	Patellars	Achilles	Abdominal	Cremasteric	Biceps	Triceps	Babinski	Clonus	Photophobia	Herpes
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TABLE 3.—DATA OF 208 CASES OF—

Class	No.	Name	Duration of Fever, Days	Developing During or After				Symptoms During Onset and Course of Disease																	No. Showing Important Comp.			
				A. Pneumonia	B. Mumps	C. Measles	D. Others	1. Headache	2. Nausea	3. Vomiting	4. Chills	5. Delirium	6. Convulsions	7. Fever, F.	8. Pulse	9. Arthritis	10. Coryza	11. Sorethroat	12. Pneumonia	13. Cough	14. Unconsciousness	15. Eruption	16. Backache	A. Panophthalmitis	B. Arthritis, Mono.	B. Arthritis, Poly.	C. Paralysis, elsewhere
C2a	1	Merrill	3		+			0+		+				103.0	96						+						
	2	Nelson	2					F+			+			104.0	108						+						
	3	Chastain	13					+	+	+	+			100.0	100							+					
	4	Jamieson	?*					F+		+				100.0	100					+	+	+					+
	5	McMillan	7					F+						102.0	112			+	+			+					
	6	Smith	?*									+		100.0	104						+						
	7	Letes	7					F+		+				97.4	62												
	8	Stewart	10					F+	+	+	+			99.8	92							+					
	9	Brumley	10					+		+				101.8	86					+		+					
	10	Foster	6					+		+	+			100.0	100						+						
	11	Jenkins	4					+		+	+			104.0	100												
	12	Thomas	D		+			+			+			99.0	74							+					
	13	Workman	D			+	Typhoid inoc.			+				102.0	98			+		+		+					
	14	Heath	5					+						103.0	84		+			+							
	15	Cloer	4					F+						101.0	90		+			+							
	16	Nelson	4					+						99.2	90					+							
	17	Stone	?					+						102.0	110			+				+					
		Total		0	2	1	1	15	2	9	6	1	0			0	2	3	1	6	5	8	0	0	0	1	0
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C2b	1	Johns	12					F+						100.0	80								+		+		
	2	Moninger	4					+		+	+		+	99.0	78								+	+			
	3	Veasey	22					+	+	+	+	+		98.0	72						+	+					
	4	Walker	*					+	+	+	+	+		101.2	88		Purpura				+	+				+	+
	5	Byrd	15					+				+		99.0	84						+						
	6	Le Fever	6					+	+	+				101.2	116												
	7	Rascoe	7					+		+		+		102.2	102							+					
	8	Cooper	8					+						99.8	96					+		+	+				
	9	Keeble	7					+	+	+				101.0	88												
	10	Wright	3								+			103.8	128		+			+							
	11	Robinson	*					F+	+	+				98.0	126						+	+				+	
	12	Perry	12					+						100.0	102						+						
	13	Stevenson	4					+						98.6	96						+						
	14	Lovelace	14		+		Otitis	1+		+				103.0	102												
	15	Cockerhan	D					F+						100.0	100								+	+			
	16	Runyam	D				Otitis				+			103.0	88												
	17	Romanquera	D											102.4	60						+	+					+
	18	Payne	D			+		F+						98.0	72								+				
	19	Hendrix	0	+			Otitis	+						103.0	96												
	20	Hampton	D								+			104.0	96			+		+							
	21	Frezevant	D					F+				+		100.0	80						+	+					
	22	Berry	D							+				98.0	60			+			+	+					
	23	Drane	21					+						102.2	96										+		
	24	Bell	19					+						101.4	92						+	+	+			+	
	25	Moss	45*					+	+	+				98.0	76		Lat. nyst.					+	+				
	26	Sanders	21					+			+			102.0	70			+	+				+	+		+	
	27	Little	1					F+	+	+				101.3	96												
	28	Armstrong	2		+			+	+	+		+		102.3	80							+					
	29	Arnold	9					+						102.0	100						+						
	30	Hanley	1									+		98.4	92						+						
	31	Scott	6					+		+		+		102.0	88					+	+						
	32	Davis	2					+						100.6	120			+		+		+					
	33	Shull	4					F+	+					100.0	64						+	+					
	34	Lynch	4		+			+	+	+				101.0	92				+	+							
	35	Lewis	5					F+	+	+				102.3	100		+			+		+					
	36	Holmes	2					+	+	+	+			102.0	90						+						
	37	Ingham	7					F+		+	+			103.2	101						+						
	38	Washington	5					F+			+		+	102.2	80						+						
	39	Wild	2					+	+					104.4	130						+	+					
	40	Black	7					+		+	+			101.2	108												
	41	Jenkins	13					F+		+	+			101.0	100							Peritonsillar abscess					
	42	Hackner	15					+		+				99.0	96							+	+				
	43	Kimball	D					+	+	+				100.0	110						+						
	44	Cross	3					+	+	+	+			103.4	90					+	+						
	45	Ross	17					+	+	+		+		103.4	92		+				+				+		
	46	Catron	17		+			+	+	+		+		105.0	102								+				
	47	Schwartzer	3					+	+	+	+			101.4	102								+				
	48	Chastant	?	+				F+	+	+	+	+	+	101.0	86					+	+	+	+			Right ulnar	
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Number Showing Important Complications								Serum Effects									Reflexes (On Admittance)											Misc.	
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TABLE 4.—Epidemic Cerebrospinal Meningitis. Summary of 208 Cases in Classes

Class	Cases	Development During or After				Symptoms During Onset and Course of Disease																Number Showing Important Complications											
		A. Pneumonia	B. Mumps	C. Measles	D. Others	1. Headache	2. Nausea	3. Vomiting	4. Chills	5. Delirium	6. Convulsions	7. Fever	8. Pulse	9. Arthritis	10. Coryza	11. Sorethroat	12. Pneumonia	13. Cough	14. Unconsciousness	15. Eruption	16. Backache	A. Panophthalmitis	B. Arthritis, Mono.	B. Arthritis, Poly.	C. Paralysis, elsewhere	C. Paralysis, Ocular	D. Epididymitis	E. Pneumonia	F. Pleurisy	G. Pericarditis, Dry	G. Pericarditis, Fluid	H. Otitis Media	I. Others
A1a	36	2	2	6	4	28	3	11	10	0	0	101.0	90	1	2	7	1	0	2	6	9	0	0	3	1	0	0	3	2	0	0	4	1
A1b	17	0	3	5	1	17	4	8	5	1	1	100.4	90	0	0	1	0	0	1	9	3	0	0	0	0	1	1	0	0	0	1	2	0
A2a	15	0	1	5	0	10	0	2	2	5	0	102.5	95	0	2	2	0	4	8	7	7	1	0	0	0	0	0	4	0	0	0	0	0
A2b	24	0	1	4	1	19	3	7	5	7	3	100.0	100	0	1	1	2	4	10	9	3	3	0	3	1	1	2	2	0	0	0	3	0
B1a	7	0	1	2	0	6	1	4	1	0	0	102.0	100	0	0	1	0	3	0	3	1	1	1	0	0	0	0	0	0	0	0	1	0
B1b	5	0	0	0	0	5	1	4	2	0	0	101.0	100	0	0	0	0	0	0	2	1	0	1	0	0	1	0	0	0	0	0	0	0
B2a	5	0	0	0	0	3	1	1	1	0	0	100.0	100	0	2	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
B2b	20	0	1	1	0	12	1	6	5	2	0	99.0	90	0	2	3	0	3	9	9	6	2	1	0	0	1	1	2	0	0	0	3	0
C1a	10	1	0	1	0	8	1	3	4	0	0	100.5	100	0	1	1	0	1	1	5	1	0	0	0	1	0	2	0	0	0	0	0	2
C1b	4	0	0	0	0	4	2	3	2	0	0	101.0	100	0	0	0	0	0	2	1	1	0	0	0	0	0	1	0	0	0	0	0	1
C2a	17	0	2	1	1	15	2	9	6	1	0	101.0	95	0	2	3	1	6	5	8	0	0	0	1	0	0	0	1	1	0	0	1	2
C2b	48	2	4	1	3	42	19	26	16	11	3	101.5	90	0	3	4	2	9	22	17	12	3	3	4	2	3	2	2	2	2	0	2	2
Total	208	5	15	26	10	169	38	84	59	27	7	.....	...	1	15	25	6	31	60	76	44	10	6	11	5	7	9	15	5	2	1	16	8
Average	..	..	..	..	..	..	..	..	..	..	..	101.0	96																				

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tenant Cobb's method when drainage is slight and symptoms persist with occasional intravenous injections of serum have given us the most satisfactory results in these difficult cases.

It has not been found necessary to follow the blood pressure either during withdrawal of spinal fluid or while giving serum intraspinally. In many hundred lumbar punctures and serum treatments no serious symptoms were observed. The well known serum effects were noted but do not require description. Only one case showed serious anaphylaxis.

Visitors to the wards where the patients are treated by the methods described remark on the absence of delirium and of the lack of subacute and chronic cases with cachexia, delirium, hydrocephalic cries and the distressing picture of the prolonged cases. In a large number the nutrition suffers little. Some patients with stormy onset ask to be allowed up and about on the fourth day. There is an air of cheerfulness and optimism about the patients, reminding one of a convalescent surgical ward. The proof of the value of this therapy is found in the shortened course, the diminished number of complications, the greater comfort of the patients, the prompt disappearance of meningococci from the spinal fluid and the decreased mortality.

CONCLUSIONS

1. A camp epidemic of 208 cases of cerebrospinal meningitis is reported.

2. The disease is in most, probably in all, instances a primary meningococcus sepsis with usual, but not necessarily universal, secondary meningitis.

3. The diagnosis can be made in at least 50 per cent. of the cases in the premeningitic stage of sepsis.

4. Treatment by large amounts of antimeningococcus serum intravenously, combined with active spinal drainage and intraspinal serum administration, has reduced the duration of the disease, the number and severity of complications and the mortality.

Acknowledgment is heartily given Capt. F. W. Baeslack, M. R. C., who with his staff has done invaluable work in the laboratory without which the clinical work of this epidemic could not have been carried out. Captain Baeslack's important contribution will be reported separately.[5]

Capt. George A. Blakeslee, M. R. C., has made neurologic observations, the necropsies, and has had general supervision of therapy. To his careful attention to details and valuable suggestion much of the therapeutic success is due. A separate report of the neurologic aspect of the epidemic will be made by him.

To the officers who from time to time have served on the Meningitis Squad acknowledgment of skilled and devoted service is made, Capts. D. L. Walker, H. S. Fincke and E. W. Barron; First Lieuts. B. Lattin, G. M. Parkhurst, Q. H. Barney, A. M. Dannenburg, L. H. Taft, F. W. Rogers, R. C. Davis, S. A. Cobb.

I am indebted to S. A. Cobb and R. C. Davis, First Lieutenants, M. R. C., for the accompanying tabulation of the epidemic.

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