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THE SERUM THERAPY OF MENINGOCOCCUS MENINGITIS

An Analysis of Fifteen Cases

SENIOR THESIS

by

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THE SERUM THERAPY OF MENINGOCOCCUS MENINGITIS

An Analysis of Fifteen Cases

The status of antimeningococcic serum in the treatment of epidemic meningitis is generally accepted as more or less of a specific. In general the mortality from this disease has been reversed from 70% to 30% since Flexner introduced his serum in 1907. However, at present there are mortality statistics reported varying from 80% to 8%, and there is no unanimity of opinion as to what constitutes the proper and most successful routine of serum administration. The routine of treatment advocated by different authors is that which has proved successful in their particular experience, and that means that the factors of epidemiology must be considered in evaluating their contribution.

It is generally conceded that the virulence of the meningococcus is greater at the height than it is during the wane of an epidemic. Furthermore, sporadic cases are usually produced by organisms of less virulence than those present during epidemics of considerable size. Necessarily then, the estimation of the value of a specific serum ^{will} ~~is going~~ to be colored by these considerations. Furthermore, the serum, to be

most efficacious, should be specific for the particular strain of meningococcus producing the disease in the particular individual being treated. To meet this requirement, commercial serums are now being produced which are polyvalent, usually containing antibodies against from 6 to 17 of the strains more frequently met. Wright (36) and others have presented considerable evidence to show that a serum is likely to lose much of its efficacy in a specific case in proportion to the number of strains that were used in producing it. Furthermore, the particular strain that is the etiological agent in the case under treatment may not be represented in the polyvalent serum used, and thus, much of the value of the serum be lost. In this connection it is noteworthy that during the epidemic of meningitis in Chicago, Ill., in 1938, 9.2% of the strains of meningococci isolated could not be typed, and Barnham (6) has shown that these organisms, although morphologically identical with the meningococci, are culturally different and has named the new organism *Neisseria flavescens*. The disease as produced by this organism was clinically indistinguishable from that produced by the true meningococcus, and the mortality was at least 30%. Such cases as these naturally throw off any statistics as to the mortality of an epidemic and discredit the antimeningococcic serum.

The method generally used to determine the specificity of the serum used in relation to the organism present in the particular case is the agglutination reaction, the serum with the highest agglutinating titre against a suspension of the organisms cultured being the one chosen for treatment. However, much adverse criticism has been directed against this method, and Wright (36) argues that the only true guide is clinical response to treatment. He shows that, in the epidemic under his observation, a serum of high agglutinin content against the 20 recorded strains was powerless to check the infection; while another serum, "though not universally high in agglutinin content against the infecting strains" and in one case "contained a lower agglutinin content than all other serums," was "specific and curative in its action in all cases when administered early."

The routine method of administering antimeningococcic serum was by lumbar puncture until in 1919 Ayer (3) introduced the technique of cisternal puncture. Since that time the introduction of the serum intracisternally has gradually gained in popularity with growing reports of the safety and increased efficacy of this method. The intravenous administration of

serum is advocated by most authorities for fulminating septicemic cases, and by many men as a routine procedure early in the disease, while the organisms are still in the blood stream. Intramuscular injections are advocated as adjuncts and in cases when for some reason the intrathecal administration is not possible. Recently some authors have advocated the intracarotid administration of serum in severe cases. Kolmer (19) considers that, when combined with cisternal or spinal drainage and medication, this method "appears to bring antibacterial agents into more widespread and intimate contact with the infected meninges than is possible by intraspinal medication alone." Ventricular puncture was introduced as early as 1908 by Cushney and Sladen but has not become a routine method of administering serum, though its value, in infants especially, in cases of ventricular block is generally conceded. Vibber and Tartakoff (32) have recently advocated a new "bubble technique" of introducing serum into the subarachnoid spaces, which they claim by the admixture of air with serum and spinal fluid effects a more rapid and widespread distribution of serum over the cortex.

Many authorities advocate as routine treatment the combined or alternate cisternal and lumbar drainage

and medication because the chief site of the inflammatory process is admittedly intracranial rather than spinal, and because, as Ayer (3) showed in 1919, the introduction of 20 cc. of fluid in the spinal canal does not reach the base of the brain, and 30 cc. barely reaches the cisterna magna, while the introduction of fluid by cisternal puncture covers the entire cortex. The importance of drainage alone as a therapeutic measure is generally recognized, but the problem of how often, how much, how long, and where to give serum routinely is by no means a settled question. The general trend in recent years has been to treat "early and intensively", but no two authors agree as to just what is meant by "intensively", nor as to what shall be the guide for stopping serum.

Fox (15) in an epidemic of 69 cases used the following routine with a mortality of 17.4%: Drainage and serum by alternate cisternal and lumbar punctures at 24 hour intervals for 4 or 5 days; then 3 or 4 punctures and serum at 48 hour intervals; then, after a 72 hour rest, a drainage puncture with smear, cell count, and culture made. Now and then a chill, fever and rigidity during the 72 hour interval called for resumption of intensive treatment.

Work (35) in an epidemic with a hospital mortality of 32.6% used the following routine: Spinal fluid drainage every 6 hours with administration intracisternally every 12 hours of 15 cc. commercial polyvalent serum; when cell count fell below 500 per cubic millimeter, serum was given every 18 hours; and when cell count fell below 100 per cubic millimeter, serum was discontinued.

Balle (5) reported one death in 26 cases, a mortality of 3.8% under the following routine: During the first 60 hours perform 5 cisternal punctures (every 12 hours) and give 30 cc. of serum at each puncture; then for the next 3 or 4 days, one puncture every 24 hours with administration of 15 cc. of serum intracisternally at each puncture; then stop the treatment even if the fluid is still cloudy, pressure high, and temperature high; if after 2 days the temperature has not fallen, fluid is markedly cloudy, pressure increased, and symptoms of meningeal irritation present, remove 25 cc. fluid by cisternal puncture and give 15 cc. serum; repeat again the following day and leave the patient alone thereafter. He claims that "the temperature generally comes down to normal in a couple of days after the serum treatment has been discontinued, but will remain high as long as it is administered," and that

the "cloudiness of the fluid can be due to leukocytosis produced by the irritation and in response to the administration of serum."

Josephine Neale (23) of the New York City Department of Public Health, from a study of 1,000 cases over a period of 20 years, believes that it is rarely necessary to give serum oftener than once in 24 hours, that it is rarely safe to give less than 4 does of serum, and that serum should be continued till 2 successive spinal fluids are free of organisms, and that the cell count by itself is of comparatively little value as a guide to treatment.

ANALYSIS OF CASES

At the University of Nebraska hospital, between November 18, 1930, and November 21, 1931, there were admitted 15 cases of meningococcus meningitis, ranging from 8 months to 59 years in age. These cases all received more or less treatment with antimeningococcic serum. Six cases died; a mortality of 40%. Four cases recovered without sequellae. One case recovered with sequella of complete bilateral deafness. Four cases recovered with sequella of hydrocephalus. No single routine of therapy was followed in treating these cases, but each was treated according to the requirements of

the individual case as seen at the time.

No attempt was made to isolate any of the strains and agglutinate them against the various commercial serums used. The serum was given in most cases by alternate injections of three or four of the available commercial serums, with the idea in mind that by using different serums the chance of not getting any specific antibodies for the particular infecting organism would be lessened. The diagnosis was not checked in all cases by culture, but all cases showed organisms on smear morphologically characteristic of the meningococcus.

First let us consider the group of fatal cases. Case summaries are given with particular reference to the details of treatment and prognostic data. (Detailed case histories are to be found in the appendix.)

CASE I: A.P., white, female, age 12 years.

Onset: Nov. 16, 1930. Admitted: Nov. 18, 1930.

Treatment instituted within 40 hours of onset.

Result: Death on the 6th day after onset.

Drainage: By 8 lumbar punctures; drainage b.i.d. and once t.i.d.

Serum: Given 90 cc. Lilly's concentrated anti-meningococcic serum intraspinally in 8 injections; given serum b.i.d. and once t.i.d.

Spinal fluid findings: Cell count 6,882 on entrance; no further counts reported, but fluid remained cloudy up to time of death.

White blood count: 17,800 on entrance; no further counts reported.

Clinical course: Temperature was 104 on entrance; reach 105.2 on the 1st day in the hospital; 107.2 on the 2nd day, and 104 on the 3rd day. No clinical improvement noted at any time. Death on the 4th day in the hospital with evidence of cardiac and respiratory collapse. No autopsy obtained.

DISCUSSION: This case illustrates the fulminating type of the disease, which shows no response whatever to serum therapy. Whether this case would have done better if treated with serum intracisternally no one can say, but nevertheless it would seem to indicate that, in this case at least, lumbar drainage and intraspinal serum were inadequate.

CASE IV: E. J., white, male, age 59 years, farmer.

Onset: Jan. 1, 1931. Admitted: Jan. 8, 1931.

Hospital days: 3.

Treatment not begun till the 5th day of illness. Diagnosis complicated by nephritis and urinary retention.

Result: Death on the 7th day of illness.

Drainage: 1 lumbar puncture; 2 cisternal punctures.

Serum: Given 60 cc. Mulford's unconcentrated antimeningococcic serum intravenously and 40 cc. Lilly's concentrated serum intracisternally.

Spinal fluid findings: Cell count was 6,200 on the first puncture made; no improvement noted in subsequent punctures.

White blood count: 7,800 on entrance. No other counts reported.

Clinical Course: Temperature was 98 on entrance; no fever till 11:45 A.M. of 1st day in hospital when temperature rose to 101; during the 2nd day the temperature rose steadily from 102 in the A.M. to 103.2 at 7:30 P.M. to 105.2 at 11:30 P.M., and to 107 at 4 A.M., shortly before death. Patient in coma throughout hospital stay; was delirious after temperature became high. No autopsy obtained.

DISCUSSION: This case shows the seriousness of epidemic meningitis in those of advanced years. A high mortality is universally quoted for patients of sixty years and over. However, the result was furthered by the fact that the patient was a known nephritic of long standing

and had had urinary retention for several months previous to this illness, and as a result was in poor condition to withstand any infection. The third factor leading to an adverse outcome was the fact that the diagnosis was delayed, and treatment not instituted until the 5th day of illness. The lack of response on the part of the patient to the infection is shown by the low leucocyte count and afebrile character of the early course of his illness. Treatment had hardly been started before the patient died, and it is a question whether one should consider this case a trial of serum therapy or not. One is practically justified in classing this patient as moribund on entrance.

CASE VIII: E.W., colored, male, age 15 months.

Onset: March 22, 1931. Admitted: March 26, 1931.

Hospital days: 9.

Treatment not instituted until the 4th day of illness.

Result: Death on 13th day of illness, 9th day in hospital.

Drainage: By alternate cisternal and lumbar punctures, b.i.d. except for the first and last days in the hospital.

Serum: Given b.i.d. except on 1st and last days

in the hospital, alternately intracisternally and intraspinally. Used alternating injections of Lilly's concentrated and Mulford's and Parke Davis' unconcentrated antimeningococcic serum. A total of 212 cc. of serum given, of which 50 cc. was Lilly's concentrated serum; intraspinally, 102 cc. of which 30 cc. was concentrated; intracisternally, 110 cc. of which 20 cc. was concentrated.

Spinal fluid findings: Cell count was 1,190 on entrance and ranged between 2,000 and 3,700 till day of death when it was 3,100. Poly preponderance throughout. No organisms seen after the 5th day.

White blood count was 17,200 on entrance; was still 16,000 on the 7th day after 6 days of intensive serum therapy,

Clinical course: Throughout illness findings suggestive, but not conclusive of pathology in lungs were reported. Absolutely no clinical improvement noted at any time. Death with evidences of medullary paralysis on 9th day.

Temperature: No improvement. Ranged between 103 and 104 till day of death.

Autopsy showed: (1) Medullary meningitis. (2) Some congestion of right lung posteriorly.

DISCUSSION: This case shows the seriousness of epidemic meningitis in the other extreme of life. Few authors report good results in cases under two years of age. Furthermore, treatment was not instituted until the 4th day of the illness, and most authorities consider the prognosis bad if treatment is not begun within 48 hours. No criticism can be raised as to the treatment not being sufficiently intensive after it was started. Both cisternal and lumbar punctures were employed, and treatment given every 12 hours, but the late start and the age of the patient were against a favorable outcome. It is doubtful if the suspicious findings in the chest had anything to do with the result.

CASE XIV: D.S., white, female, age 8 months.

Onset: September 8, 1931. Admitted: September 8, 1931. Hospital days: 11

Treatment not instituted till the 7th day after onset.

Result: Death on the 11th day after onset of meningeal symptoms.

Drainage: Repeated lumbar and cisternal punctures failed to draw fluid. On the 7th day ventricular puncture was resorted to and proved successful, and was repeated daily till the day of death.

Serum: Given 40 cc. of antimeningococcic serum intraventricularly, of which 20 cc. was Lilly's concentrated serum.

Spinal fluid findings: Cell count was 1,280 on 7th day. No other counts reported but fluid remained cloudy till day of death.

White blood count: was 15,300 on the 9th day. No other count reported.

Clinical course: Temperature was relatively low throughout hospital stay, 102.6 on entrance being the highest noted. (Patient was receiving hourly doses of aspirin gr. 1.) No clinical improvement was noted at any time. No autopsy was obtained.

DISCUSSION: This case also illustrates the difficulty in treating infants successfully. In this instance also, we see the impossibility of relying entirely on lumbar and cisternal puncture. In infants spinal and cisternal taps are not infrequently dry, and on the other hand, ventricular puncture is a relatively feasible procedure because of the unclosed fontanelles. However, in criticism of the treatment in this case, (even though no one of experience were available, if that were the reason for not attempting ventricular puncture till the 7th day in the hospital) the patient should have received serum intramuscularly early in the course of the hospital stay.

CASE IX: A.S., white, female, married, age 48 years

Onset: April 12, 1931. Admitted: April 15, 1931. Hospital days: 21.

Treatment instituted on the 5th day of illness. Patient was transferred from a local hospital to University hospital on 4th day of illness.

Result: Death on the 26th day of illness, the 21st day in the hospital.

Drainage: B.i.d. by alternate cisternal and lumbar punctures on 1st and 2nd days; once by lumbar puncture on the 3rd day; twice by cisternal punctures on the 4th day because lumbar puncture was dry; and by alternate cisternal and lumbar punctures once daily from the 5th to the 19th days in the hospital with the exception of the 6th, 11th, 16th and 18th days. Was drained twice on the 20th day by cisternal and lumbar punctures.

Serum: Given alternate injections of Lilly's concentrated and Mulford's and Parke Davis' unconcentrated antimeningococcic serum; once on the 1st day; b.i.d. on the 2nd day; once on the 3rd day; b.i.d. on the 4th day; and once daily from the 5th to the 20th days with the exception of the 6th, 11th, 16th, and 18th days. A total of 263 cc. serum given, of

which 95 cc. was Lilly's concentrated; intracisternally, 165 cc. of which 25 cc. was Lilly's concentrated; and intraspinally, 98 cc. of which 20 cc. was concentrated.

Spinal fluid findings: Cell count was 8,000 on entrance; fell to 2,200 on the 3rd day; was 2,500 on the 7th day, and 2,600 on the 10th and 13th days. No more cell counts were reported, but the spinal fluid became fairly clear on the 15th day and was only slightly cloudy on the 17th day, but became very cloudy on the day before death. No organisms were reported on the 10th day, and culture then was negative.

White blood count: Was 15,500 on entrance; fell to 10,800 on the 11th day.

Clinical course: The patient ran a low temperature course throughout. Highest noted during hospital stay was 101.3. Clinical improvement was noted up to about the 10th day, after which patient's condition became more or less static with poor fluid intake and increased spinal fluid pressure. Patient's urine consistently ran 2 to 4 plus sugar and 1 or 2 plus albumen. Blood sugar was 151 mg% on 2nd day and 126 mg% on 3rd day. No history of diabetes obtained; patient was not on insulin in University hospital. Paralysis of bladder developed on 5th day with persistence of involuntary

urination and necessity of frequent catheterization for residual urine up to time of death. Death on the 21st day was sudden and not particularly anticipated.

Autopsy showed: 1. Suppurative basilar meningitis. 2. Cerebro-spinal fluid block. 3. Internal hydrocephalus. 4. Intracranial pressure.

DISCUSSION: Here again, is a case in which treatment was not instituted until late in the disease; however, the patient showed considerable improvement under intensive serum therapy up to the 10th day. Little clinical evidence of the hydrocephalic state disclosed at autopsy was to be found in the case history, but this condition was probably of considerable importance in causing her death on the 21st day in the hospital. The advisability of the continuance of serum injections after the initial improvement clinically and in the spinal fluid cell count after the 3rd day in the hospital is rather doubtful. In retrospect one would be inclined to believe that the maintenance of the spinal fluid cell count around 2,500 from the 4th day on was probably due to the introduction of foreign protein into the subarachnoid space in the form of serum, and that possibly such a reaction may have been in a large part responsible for the fluid block and resulting hydrocephalus.

The persistent finding of sugar in the urine, despite the two fairly low blood sugars reported, is suggestive of a diabetic condition. If such were the case, the fact that the patient did not receive any insulin during her stay in the hospital may have been an important factor in the outcome, and of course, if diabetic, her prognosis would have been poorer in any case.

CASE XI: L.S., white, male, age 14 years.

Onset: March 26, 1931. Admitted to local hospital: March 27, 1931. Transferred to University Hospital: April 25, 1931, because after 4 weeks of treatment patient became delirious and had convulsions.

Treatment instituted in another hospital within 36 hours of onset.

Result: Death on the 43rd day of illness, the 13th day in University hospital. Complications: hydrocephalus and cerebrospinal fluid block apparently developing about 3rd or 4th week of illness; suppurative otitis media and mastoiditis, of streptococcus origin, as a terminal condition.

Drainage: Details of early treatment not available, except that drainage was exclusively by lumbar punctures. On the 3rd day in the University hospital (the 33rd day of illness) lumbar puncture only yielded 4 cc. and on the 10th day in hospital was completely

dry. Cisternal punctures were done on the 4th, 5th, 7th, 11th (twice), 12th, and 13th days in the hospital.

Serum: Details of early treatment unavailable except that alternate injections of Lilly's, Mulford's, and Parke Davis' serum were used, and serum only given intraspinally and twice intravenously. In the hospital patient was given 6 intracisternal injections totaling 89 cc. serum, of which 37 cc was Lilly's concentrated serum, on the 5th, 7th, 10th, 11th, 12th, and 13th days in the hospital.

Spinal fluid findings: First cell count 36 hours after onset was 23,000; fell to 1,700 36 hours later; fluid clear by lumbar puncture on the 25th day of illness, and again on the 33rd day (3rd day in University hospital) cells were only 70 and no organisms seen. But on the 4th day in the hospital by cisternal puncture cells were 1,500 and numerous intracellular meningococci were seen. Under intracisternal serum therapy this fell to 590 cells and no organisms on the 11th day, but further improvement did not occur.

Clinical course: Temperature course early not available. In the University hospital temperature ran around 100 to 101, occasionally reaching 102. Patient showed definite clinical improvement during the 1st

week after the onset. Subsequently no improvement under continued serum therapy. During the 3rd week of illness developed delirium alternating with stupor and involuntary urination. During the 4th week, convulsions, and an increased and irregular pulse rate. During the 5th week slight improvement under intracisternal drainage and serum. Last few days developed a suppurative otitis media and mastoiditis of streptococcus origin, and death on the 43rd day of illness.

Autopsy findings: 1. Suppurative basilar meningitis. 2. Cerebro-spinal fluid block at base. 3. Internal hydrocephalus. 4. Intracranial pressure. 5. Left suppurative otitis media and mastoiditis (hemolytic streptococcus isolated.)

DISCUSSION: This case illustrates the inadequacy of exclusive lumbar drainage and medication. If the early treatment in the local hospital had included cisternal drainage and medication the spinal block might not have developed, and in any event, it would have been unlikely that on the 34th day of his illness the cisternal tap would have shown an active focus of meningococcic infection when the lumbar taps had been clear for several weeks. It is also significant that the physician who referred the patient from the local hospital should note

(Appendix) that the "response to intraspinal serum was quite marked for the first week; after that not much effect." Possibly the continuance of the serum was a factor in producing the spinal block as a result of a foreign protein reaction in the spinal subarachnoid spaces. The clinical improvement during the first week under cisternal drainage and serum is pleasing to note, but it is a question whether the outcome would have been any different even had the patient not developed a streptococcus otitis media and mastoiditis to tip the scales adversely.

While we are discussing the question of hydrocephalus and spinal fluid block, let us next consider the cases that recovered but with residual of hydrocephalus. There were four such cases.

CASE V: J.S., white, female, age 4 years.

Onset: March 1, 1931. Admitted: March 4, 1931.
Hospital days: 65. Treatment instituted within 72 hours of onset.

Result: Recovery with sequellae of internal hydrocephalus and complete bilateral deafness, developing on the 15th day in the hospital.

Drainage: Alternate cisternal and lumbar punctures, b.i.d. for 9 days, then daily lumbar punctures

for the rest of the stay in the hospital, draining from 20 to 60 cc. each time.

Serum: Given alternately Lilly's concentrated, Mulford's and Parke Davis' unconcentrated antimeningococcic serum, b.i.d. for 8 days, then once a day till the 15th day. Intraspinally: 270 cc. of which 70 cc. was Lilly's concentrated serum; intracisternally: 52.5 cc. of which 30 cc. was Lilly's concentrated serum. Total of 322.5 cc. of which 100 cc. was Lilly's concentrated serum.

Spinal fluid findings: Cell count was 25,600 on entrance; dropped to 7,200 on the 4th day, to 2,700 on the 8th day, and ranged between 1,200 and 2,000 until the 15th day when it suddenly dropped to 180 and on the sixteenth day first showed a preponderance of lymphocytes. No organisms were seen after the 7th day. Cultures were negative for meningococci throughout.

White blood count: Was 26,000 on entrance; was still 22,000 on the 8th day, after continuous serum therapy b.i.d.; fell to 7,200 on the 14th day, after a week of serum only once daily. Subsequent counts ranged between 12,000 and 8,700.

Clinical course: Temperature was 103 on entrance; rose to daily peaks of 103 to 104.4 during the 1st week;

after the 7th day ranged between 99 and 102, and became flat on the 15th day in the hospital, the day serum was discontinued. Slight clinical improvement was noted on the 5th day; definite improvement on the 7th day. Symptoms of hydrocephalus and deafness developed on the 15th day. Gradual improvement under dehydration therapy and frequent spinal drainage. Patient dismissed on the 65th day in the hospital in a static condition, spinal fluid pressure reasonably low.

DISCUSSION: Treatment in this case was not instituted as promptly as could be desired, and the response to serum was rather sluggish. The disappearance of the meningococci from the spinal fluid is usually the earliest sign of response to treatment, and in this series of cases usually occurred after one or two days of treatment. But in this case organisms were seen on the seventh day. This would seem to indicate that, although three different commercial serums were used, the antibodies were not specific for the etiological organism in this particular infection. The use of alternate cisternal and lumbar punctures every 12 hours is to be commended, and according to most authorities should aid in preventing spinal fluid block and hydro-

cephalus. In this instance, while no spinal block occurred, ventricular block was produced. This unfortunate complication was in all probability the result of the prolonged inflammatory process in the cranial cerebro-spinal fluid pathways. But the significance of the persistent spinal fluid cell count around 1,200 to 2,000 between the 8th and the 15th days, when the patient was receiving serum daily, when the temperature was relatively low, and when the patient was definitely improved clinically, would seem to be that the continuance of serum after the 8th day was probably producing considerable foreign protein reaction in the meninges and possibly even prolonging the exudative process which resulted in ventricular block on the 15th day. The impracticability of using the white blood count as a prognostic guide is shown by the count of 22,000 on the 8th day when, if our above contentions are accepted, the patient was definitely improved, and serum should have been discontinued. Possibly this high leucocyte count was also the result of the continuous injection of foreign protein.

CASE VI: J.G., colored, female, age 13 years.

Onset: March 6, 1931. Admitted: March 9, 1931.

Hospital days: 70

Treatment instituted within 2 days of onset of meningeal symptoms.

Result: Recovery with sequella of internal hydrocephalus, symptoms of which developed on 34th day in the hospital.

Drainage: By 18 cisternal punctures and 19 lumbar punctures of which 3 were dry taps. With the exception of the first day, drainage was b.i.d. for 7 days, by alternate cisternal and lumbar punctures from the 2nd to the 4th days and on the 7th day again. On the 9th day lumbar puncture was dry; so daily cisternal puncture was done till the 23rd day. After that 2 cisternal punctures 4 days apart to check fluid and pressure. On the 46th day daily lumbar punctures were resumed to relieve increased pressure; continued for 4 days. Then occasional lumbar puncture as needed. All punctures were discontinued on the 63rd day.

Serum: Given alternately Lilly's concentrated antimeningococcic serum and Mulford's and Parke Davis' unconcentrated serum. A total of 340 cc. serum given of which 90 cc. was Lilly's concentrated serum: intraspinally, 160 cc. (of which 55 cc. was Lilly's concentrated) in 11 injections; intracisternally, 180 cc. (of which 35 cc. was Lilly's concentrated) in 12 inje-

tions. Serum given b.i.d. for 7 days except for the first day. Then once daily till the 15th day, and again on the 17th and 18th days because poly predominance had developed again in the spinal fluid. Serum discontinued after the 18th day.

Spinal fluid findings: Cell count 6,700 on entrance; fell to 2,300 on 5th day; rose to 13,500 on 6th day; fell to 1,500 on 7th day and to 640 on 9th day. On the 11th day was 400 with predominance of lymphs for the first time, although temperature was highest to date; rose to 1,340 on 14th day. On 16th day after no serum for 48 hours cell count fell to 120, but on the 17th day rose, without any serum therapy, to 587 with again a poly preponderance. On 19th day, after 2 days of serum, cell count was 6,720 and lymphs and polys equal, but fluid was xanthochromic, indicating hemorrhage. On 22nd day, after no serum for 4 days, cell count was 220 and lymphs predominant. Meningococci were never numerous on smear, but were occasionally seen as late as the 10th day.

White blood count: Was 36,500 on entrance. A marked drop to 14,000 was noted on the 11th day, but leucocytes were still 10,600 on the 24th day, 7 days after all serum had been discontinued.

Clinical course: Temperature never rose above 102 till the 11th day, when patient developed a severe headache within half an hour after receiving serum intracisternally, and had a chill and rise in temperature to 103.2 five hours later. Temperature, under continued serum once a day, was high on the 13th and 14th days, when the cell count rose, although the lymphs predominated in the spinal fluid at this time. On the 17th day, after no serum for 72 hours, temperature was 100 in the morning, but following an intracisternal injection of serum, the patient developed severe pain in head and abdomen, and 5 hours after serum injection temperature rose to 103.4 and was 104 four hours later. On the 18th day the same reaction followed the administration of serum with the additional symptom of an urticarial eruption on the arms. The serum reaction was then recognized and serum discontinued, and temperature 2 days later fell to 100. Temperature became definitely flat 10 days later. Spinal block developed on the 9th day. Symptoms of hydrocephalus developed on the 34th day, and condition on dismissal on the 70th day showed little improvement though spinal fluid pressure was fairly close to normal.

DISCUSSION: This case, with an onset during the same week as that of the previous case discussed, also showed a slow disappearance of organisms in the spinal fluid, possibly indicating a lack of specific antibodies in the serums used against the particular organism producing the infection. In this instance treatment instituted within 48 hours of the appearance of meningeal symptoms, which is considered to be the late limit of early treatment. The use of alternate cisternal and lumbar punctures did not prevent the development of spinal block on the 9th day, though this routine was not strictly followed every day. The use of the polymorphonuclear-lymphocytic ratio in the spinal fluid as a guide for serum administration in this case apparently led to prolonging serum injections till the 18th day and to a definite intracranial and general serum reaction on the 17th and 18th days, characterized by high fever, severe headache, pains in abdomen, and urticarial eruption over the arms on the 18th day, and a rise in the cell count from under 1,000 to 6,720 on the 19th day. These findings seem fairly conclusive that serum administration was prolonged beyond the period of usefulness. Whether the edema of the brain and exudative reaction apparently responsible for these

symptoms were of etiological significance in the development of the hydrocephalic condition noted on the 34th day is a question. Likewise, it is questionable whether serum should have been entirely discontinued after the first week of treatment, with the marked improvement in the cell count, but in the face of finding occasional organisms in the fluid as late as the 10th day. The chill and fever following the administration of serum on the 11th day, in view of the markedly improved spinal fluid findings on that date, should probably have been taken as a warning to discontinue serum.

CASE VII: G.J., colored, male, age 29 months.

Onset: March 21, 1931. Admitted: March 23, 1931.

Hospital days: 45

Treatment instituted within 48 hours of onset of meningeal symptoms.

Result: Recovery with complication of internal hydrocephalus, symptoms of which developed on the 13th day in hospital. Dismissed in improved condition pressure fairly low, and no sensory or motor sequelae.

Drainage: B.i.d. for the first 12 days, with the exception of 1st day, by alternate cisternal and lumbar punctures; one cisternal puncture on the 13th day and a lumbar puncture on the 14th day. Then from the 17th to the 32nd days lumbar punctures daily, or

every other day, to relieve pressure; in all 14 punctures during this interval draining from 20 to 52 cc. of fluid each time. On the 33rd day an encephalogram was made, and following that only three lumbar punctures were made to check pressure till patient dismissed on 45th day.

Serum: Alternate injections of Lilly's concentrated antimeningococcic serum and Mulford's and Parke Davis' unconcentrated serum were used. Given b.i.d. alternately intraspinally and intracisternally for 12 days with the exception of the first day. Given incisternally on the 13th day and once intraspinally on the 14th day. A total of 365 cc. of serum given, of which 85 cc. was Lilly's concentrated: 30 cc. were given intravenously; 165 cc. intracisternally, of which 30 cc. was Lilly's concentrated serum; 170 cc. intraspinally, of which 55 cc. was Lilly's concentrated serum.

Spinal fluid findings: Cell count was 5,330 on entrance; fell to 2,800 on 5th day; ranged between 780 and 1,400 till the 12th day under continued serum therapy b.i.d.; was 480 on the 13th day; and on the 14th, after serum had been given only once on the 13th day, cell count fell to 194, and remained low thereafter. The ratio of lymphs and polys in equal proportions first

noted on the 12th day, and the return of lymphocyte preponderance on the 14th day. No organisms were seen after the 4th day. Culture positive for meningococcus on entrance only.

White blood count: 17,950 on entrance; fell to 7,200 on 4th day, and under continued serum therapy was 10,300 on the 11th day.

Clinical Course: Temperature ranged around 103 and 104 daily peaks, except for the 6th day when it only reached 102.4, till the 11th day when lysis began; became definitely flat on the 17th day, 2 days after all serum was discontinued. Pulse was high till serum was discontinued and then became irregular as a result of intercranial pressure. Clinical improvement was negligible under continuous serum therapy. After onset of hydrocephalus on 13th day patient went into collapse on the 14th and 24th days, but responded to vigorous treatment with stimulants, spinal drainage, and intravenous hypertonic glucose. Following the encephalogram done on 33rd day, the intracranial pressure seemed to improve, and when patient was dismissed on the 45th day the spinal fluid pressure was fairly low.

DISCUSSION: This case under fairly early treatment by alternate cisternal and lumbar punctures every 12 hours showed definite improvement in the spinal fluid findings by the 5th day, but because the temperature

remained high, serum was continued twice a day till the 12th day, with negligible improvement in spinal fluid findings till the 11th day and continued high temperature. While there was no marked rise in the cell count to indicate an exudative reaction to this prolonged serum administration, such as was found in the previous cases, the continued fever and persistence of the cell count around 1,000 would seem to indicate that the serum had been prolonged beyond the period of usefulness, and had the serum been discontinued after 5 or 6 days treatment the temperature would probably have fallen and the spinal fluid have cleared, as Balle (5) contends. Again the hydrocephalus, developing on the 13th day, may bear some relation to the prolonged serum administration, as discussed in the previous cases. The prompt response to intravenous hypertonic glucose solution in the periods of collapse after hydrocephalus had developed is noteworthy, as well as the apparent improvement in the intracranial pressure following the encephalogram.

CASE XII: B.H., white, female, age 2 years.

Onset: May 23, 1931. Admitted: May 25, 1931.

Hospital days: 92.

Treatment instituted within 48 hours of onset of meningeal symptoms.

Result: Recovery with sequella of internal hydrocephalus, symptoms of which were noted on the 24th day; and complicated by a staphylococcus aureus meningitis developing on the 47th day in the hospital.

Drainage: Once daily on the 1st and 2nd days; b.i.d. from the 3rd to the 15th days except for the 8th and 10th days, when drained t.i.d. because of hyperpyrexia, rigidity and stupor; daily drainage from the 24th day on, for increased intracranial pressure. Drainage by cisternal puncture on the 1st day; by 3 lumbar punctures during the 2nd and 3rd days; by alternate cisternal and lumbar punctures on the 4th and 5th days; and by cisternal punctures entirely from the 6th to the 15th days with the exception of one lumbar puncture on the 6th, 8th, and 15th days. Practically daily lumbar drains after the 24th day to relieve increased pressure, and between the 47th and 68th days for the staphylococcus aureus meningitis.

Serum: Given once intracisternally on the 1st day; once intraspinally on the 2nd day; twice intraspinally on the 3rd day; and once intracisternally on the 4th day. Then discontinued because of improved temperature and spinal fluid findings 48 hours later, serum was resumed. Given intracisternally exclusively from the 6th to 15th days except for once intraspinally

on the 8th and again on the 15th day; given once on the 6th and 7th days; t.i.d. on the 8th and 10th days because of the hyperpyrexia, rigidity, stupor, distention, and irregular pulse; and given b.i.d. the rest of the time. Serum was discontinued after the 15th day. Alternate injections of Lilly's concentrated and Mulford's and Parke Davis' unconcentrated serum were used. Total of 335 cc. serum given in 25 injections, of which 75 cc. was Lilly's concentrated serum; intracisternally, a total of 285 cc. of which 40 cc. was concentrated serum; intraspinally, a total of 50 cc. of which 35 cc. was concentrated serum; no serum given intravenously.

Spinal fluid findings: Cell count was 9,800 on entrance; fluid was quite clear, although no cell count was made, and no organisms seen on the 4th day; on the 5th day the polys in the spinal fluid were only 20% and no organisms seen; (serum discontinued.) But on the 6th day after no serum for 48 hours, the polys rose to 84% and rare intracellular organisms were reported; then under resumed serum therapy, the poly predominance persisted till the 15th day, when polys fell to 28%. A few organisms were reported on the 9th, 11th, and 12th days. Cell count on the 9th day was

2,520 and fluid remained cloudy till the 12th day; on the 13th day cell count fell to 50. Spinal fluid remained clear till the 47th day when it became cloudy, cells 2,750, and smear and culture showed staphylococcus aureus. Fluid became clear again on the 52nd day, and no staphylococci reported after that date. Fluid remained clear for rest of hospital stay.

White blood count: Was 17,500 on the 2nd day; fell to 14,200 on the 6th day; rose to 18,000 under continued serum therapy on the 9th day. No other counts reported.

Clinical course: Temperature was 100.4 on entrance; reached 104 on the 3rd day; fell to 98 on the 4th day; and was only 101.4 and 102 on the 5th and 6th days; but jumped to 104.6 on the 7th day after serum was resumed because of reappearance of organisms and poly predominance in the spinal fluid; Temperature reached 105.8 on the 8th, 9th, and 10th days, accompanied by marked rigidity, stupor, distention and irregular pulse; remained around 103 and 104 under intensive serum therapy till the 13th day when it fell to 98.6 and remained flat thereafter till the 24th day when temperature flared up to 103 and definite signs of hydrocephalus were apparent, but no evidence of any

spinal fluid infection. Temperature again approached normal by the 38th day; but on the 47th day it flared up to 104 with findings of a staphylococcus aureus meningitis. Temperature remained high and irregular till the 68th day when it returned to normal and remained so till patient was dismissed to the County hospital on the 92nd day in the University hospital. Condition upon dismissal definitely hydrocephalic, spinal fluid pressure reasonably close to normal, mentally clouded.

DISCUSSION: Treatment was started within 48 hours in this case, and the routine of drainage and serum twice a day by both cisternal and lumbar punctures was followed. The marked improvement clinically and in spinal fluid findings apparently justified discontinuing the administration of serum on the 5th day, according to our argument in the previous cases, but persistence of organisms in the spinal fluid as late as the 13th day and the return of the polymorphonuclear predominance would seem to indicate a lack of specificity on the part of the serums used against this particular infecting organism. If such were the case, it is doubtful whether the prolonged use of serum till the 15th day was of much benefit when weighed against the possibility of meningeal serum reaction, as discussed

previously. However, the spinal fluid became clear and the cell count fell to 50 two days before the serum was discontinued; so that apparently there was no reaction to the continued use of serum, and the improvement was probably due to the serum as well as to the continued drainage. This case would seem to show that relapses after the discontinuation of serum therapy are apt to be quite difficult to control, possibly due to a lack of specificity in the serum antibodies as above noted. The appearance of hydrocephalus on the 24th day does not appear to be related to the method of treatment, other than by analogy to the previous cases discussed through the fact of prolonged intensive treatment. The importance of drainage alone as a therapeutic measure in meningeal infections is well shown by the recovery of the patient from the staphylococcal meningitis which developed on the 47th day. Possibly, in cases in which the antimeningococcal serum does not seem to have a specific action on the organism, the patient would do better under frequent drainage without serum, and not run the chance of developing an exudative meningeal reaction to the foreign protein of the serum.

The next five cases all recovered without sequellae, except one which developed complete bilateral deafness within 12 hours of the onset. They were not all treated with the same routine of procedure, and some rather interesting deductions may be drawn from their case records.

CASE II: E.B., white, female, married, age 19 years.

Admitted: Dec. 2, 1931. Hospital days: 24

Onset: December 1, 1931.

Treatment instituted within 36 hours of onset.

Result: Recovery without sequellae, but complicated by serum reaction beginning on 7th day.

Drainage: 13 lumbar punctures removing approximately 277 cc., and 5 cisternal punctures removing 130 cc. of fluid. Drainage b.i.d. for 5 days; then daily for 10 days.

Serum: Given alternately intracisternally and intraspinally for 5 days; then patient developed a serum reaction of the seventh day, and serum was given in 5 intramuscular injections during the next 8 days. Total serum: intravenously, 120 cc. Mulford's unconcentrated; intramuscularly, 40 cc. Lilly's concentrated, and 10 cc. Mulford's unconcentrated; intracisternally, 65 cc. Lilly's concentrated; intraspinally, 90 cc. Lilly's concentrated. Total serum 325 cc. over a period

of 15 days.

Spinal fluid findings: Cell count fell from 17,000 on entrance to 685 after 3 days of treatment; rose to between 4,000 and 5,000 until the intracis-ternal and intraspinal treatment was discontinued. On the day of serum reaction was 22,500, but on the next day fell to 155 and remained about 100 till after the fourth intramuscular injection when it rose to 490. After serum was discontinued cell count fell to 110. The predominance of polys persisted even till the last cell count on the 16th day. No organisms seen after 3rd day.

White blood count was not run daily, but on the 9th day, two days after the serum reaction developed, it was down to 9,200, even though the temperature was still 101.F.

Clinical Course: Temperature was 104 on entrance; reached daily peaks of 102 and 103 till the 10th day when it dropped to around 99.6, within two days after the intraspinal treatment was discontinued. Temperature flared up again following the intramuscular injections, and remained flat after serum was discontinued on 15th day. Clinical improvement was noted on 4th day. Serum reaction developed on 7th day. Gradual improvement after 15th day. Patient dismissed on 24th day; recovered. No sequellae noted when seen 1 year later.

DISCUSSION; Treatment in this case was instituted within 36 hours of the onset. The patient was treated intensively by alternate cisternal and lumbar drainage and serum injection twice daily for 5 days when a severe general and meningeal serum reaction forced a discontinuation of intrathecal administration of serum. The serum in this instance seemed to be quite specific, the spinal fluid showing a marked fall in the cell count and an absence of organisms on the 4th day. However, the general serum reaction of the 7th day was presaged by a rise in the cell count on the 5th and 6th days although no organisms were seen. The rapid fall in temperature and cell count within 2 days after the intraspinal serum was discontinued would seem to bear out Balle's (5) contention that serum should be arbitrarily discontinued after 5 or 6 days intensive treatment, otherwise the temperature and cell count will be maintained by the foreign protein reaction. The value of the intramuscular injections of serum in this case following the discontinuation of intraspinal serum is questionable.

CASE III: M.D., colored, female, age 12 years.

Onset: Dec. 19, 1930. Admitted: Dec. 21, 1930.

Hospital days: 36

Treatment instituted within 48 hours of onset of meningeal symptoms.

Result: Recovered without sequelae.

Drainage: 35 lumbar punctures removing about 1155 cc of fluid. 3 cisternal punctures removing 130 cc of fluid. Drainage b.i.d. for 13 days.

Serum: Given 60 cc. Mulford's unconcentrated serum intravenously; 50 cc. Lilly's concentrated serum intracisternally; and 170 cc. Lilly's concentrated, 60 cc. Parke Davis', and 15 cc. Mulford's unconcentrated serum intraspinally; a total of 355 cc. antimeningococcic serum. Serum was given b.i.d. for three days once on the fourth day, twice on the fifth day because of increased rigidity, once on the sixth and seventh days and intravenously on the eighth day: On the ninth day the brand of serum was changed because no clinical improvement was noticed, and serum given twice. It was given once daily for the following three days; still with no improvement.

Spinal fluid findings: Cell count fell to 1,010 on the fifth day. Rose under continued intraspinal serum therapy to 5,100 on the evening of the seventh day. Fell to 490 during the 48 hours rest from intraspinal serum. Rose to 7,400 following renewal of serum,

and during the four days that serum was given once a day and drainage done b.i.d. the cell count 12 hours after the serum was given ranged around 5,000 while the fluid 24 hours after serum had been given showed a cell count of 1,200 to 1,600. After serum was discontinued the cell count promptly fell below 1,000 and remained low except when the xanthochromic character of the fluid indicated some hemorrhage into the subarachnoid space. The poly predominance did not disappear till after all serum had been discontinued. No organisms were reported after the 1st day.

White blood count: On seventh day was 12,000, but under continued serum therapy rose to 17,800 on the ninth and 15,200 on the eleventh and 14,100 on the thirteenth days, and did not fall to 9,100 till the fifteenth day, after all serum had been discontinued for two days.

Clinical Course: Temperature was 104.5 on entrance; ranged between 103 and 104.6 till the 9th day when it fell to 101.3; on the 10th day, after 60 cc serum had been given intravenously the day before, temperature rose to 105 with resumption of intraspinal serum; temperature ranged between 101.3 and 103 till the 15th day, 2 days after all serum had been discontinued, when it

fell to normal and remained flat till dismissed. No clinical improvement was noted till the 16th day. Patient had difficulty in taking fluids. Patient gradually improved and was dismissed on 36th day; recovered with no sequellae.

DISCUSSION: This case had treatment started early, and was treated intensively, twice a day for four of the first five days. The serum used seemed to be effective as regards causing the organisms to disappear from the spinal fluid and reducing the cell count to 1,010 by the 5th day, but in attempting to bring the cell count and temperature down by continuous serum therapy, a meningeal irritation resulted sufficient to produce the very significant cell counts noted above and to keep the temperature high. The possibility of the patient being overtreated was not realized until the 14th day when serum was discontinued, and prompt clinical improvement occurred within 3 days. In this case the meningeal reaction to the foreign protein was sufficient to prevent clinical improvement, but fortunately did not produce any block, as it was suspected of having done in the previous cases discussed. The foreign protein reaction was also mirrored in the blood stream in the increased leucocyte count, as well as in

the persistent polymorphonuclear predominance in the spinal fluid, showing the futility of using these findings as prognostic guides in giving serum. This case is also an argument for the arbitrary administration and discontinuation of serum as previously discussed.

CASE X: E.H., white, female, age 23 years, married.

Onset: April 22, 1931. Admitted: April 24, 1931.

Hospital days: 18.

Treatment instituted within 48 hours of onset.

Result: Recovery without sequellae, but complicated by local abscess at site of spinal drainage.

Drainage: 1 lumbar puncture on 1st day in hospital; 2 lumbar punctures on 2nd day; permanent lumbar drainage by small spinal trochar for 6 days from 2nd day to 7th day.

Serum: Given once intraspinally on 1st and 2nd days; once intravenously on 1st, 2nd, and 4th days. No serum after the 4th day. Total of 120 cc. serum, of which 30 cc. was in 2 intraspinal injections and 90 cc. was in 3 intravenous injections.

Spinal fluid findings: Cell count was 18,500 on entrance; fell to 1,000 on the 4th day, after 2 days of continuous drainage; fell to 140 on the 6th

day, after 5 days of continuous drainage and after no serum for 2 days. Culture negative on the 2nd day. No organisms seen after the 2nd day.

White blood count: 10,150 on entrance; was 14,900 on the 2nd day. No counts reported thereafter. Urinalysis on 2nd and 5th days showed 3 plus albumen, many casts, and some R.B.C.

Clinical Course: Temperature reached 102 on the 1st day; ranged around 101 till the 7th day except for a peak of 103 on the 4th day, following the 3rd intravenous injection of serum. From the 7th to the 14th day patient ran a temperature around 100 as a result of abscess at site of trochar wound. Temperature normal after the 14th day. Clinical improvement noted on the 3rd day, after 1 day of continuous drainage. Steady improvement noted till 7th day. Subsequent hospital stay lengthened by local abscess formation.

DISCUSSION: This case is of special interest because of the permanent spinal drainage employed, and because of the relatively small amount of serum given intraspinally. The serum was apparently quite specific in action since organisms disappeared from the spinal fluid after the second day. The continuous drainage was undoubtedly very effective, as the spinal fluid

cell count rapidly fell under this procedure. There was no question of overtreatment with serum intraspinally in this case, and the effectiveness of the routine of adequate drainage combined with early, intensive serum administration for three days only is significant. The development of the localized abscess at the site of the permanent drain was unfortunate, but whether such a complication is to be looked for in every case treated by this procedure is doubtful.

CASE XIII: L.G., white, male, age 3 years.

Onset: May 23, 1931. Admitted: May 25, 1931.

Hospital days: 21

Treatment instituted within 72 hours of onset.

Result: Recovery without sequelae or complications.

Drainage: By lumbar puncture on the 2nd day in hospital; by alternate cisternal and lumbar punctures b.i.d. thereafter till the 8th day; by one cisternal puncture on the 9th and again on the 10th day. Spinal fluid checked by lumbar puncture on the 13th day.

Serum: Given 4 injections, alternate intraspinal and intracisternal, totaling 50 cc. antimeningococcic serum, of which 20 cc. was Lilly's concentrated serum. No serum given after the morning of the 4th day.

Spinal fluid findings: Cell count was 900 on entrance; no further counts reported till the 9th day when 40 cells were counted, but spinal fluid was fairly clear by the 5th day, 36 hours after serum was discontinued. The poly predominance did not disappear till the 10th day. No organisms were seen after the 2nd day in the hospital.

White blood count: 34,000 on entrance; fell to 13,500 on the 3rd day. No counts reported thereafter.

Clinical Course: Temperature was 102.6 on entrance; reached 103.4 on the 3rd day; reached normal on the evening of the 4th day, 12 hours after the last serum had been given; and became flat by the 7th day and remained so thereafter. Clinical improvement was noted by the 3rd day, the 2nd day after serum therapy was instituted. Steady improvement in general condition up to dismissal on 18th day.

DISCUSSION: This case illustrates a remarkably prompt response to serum therapy, especially as treatment was not instituted till the 3rd day after onset. Whether this indicates that the infecting strain was of low virulence or that the serum contained a particularly high content of specific antibodies for that particular strain it is impossible to say. It is

significant, however, that, as in the previous case, serum administration was not prolonged beyond the fourth day, and subsequent treatment consisted of frequent drainage only.

CASE XV: D.G., white, female, age 14 years.

Onset: November 19, 1931. Admitted: November 21, 1931. Hospital days: 21.

Treatment instituted within 68 hours of onset.

Result: Recovery, complicated by serum reaction on the 4th to 8th days, and with sequella of total deafness, bilateral.

Drainage: By 2 lumbar punctures and 1 cisternal puncture on the 1st day in the hospital; by lumbar punctures b.i.d. thereafter till the 7th day; by 1 lumbar puncture on the 8th and 9th days.

Serum: Given intrathecally t.i.d. on the 1st day, b.i.d. on the 2nd day, and once on the 3rd and 5th days. Given 3 intravenous injections in the first 3 days, totaling 30 cc. serum; given 1 intramuscular injection of 8 cc. serum on the 1st day; given 1 intracisternal injection of 22 cc. serum on the first day; and given 110 cc. serum intraspinally. A total of 170 cc. antimeningococcic serum of which 20 cc. was Lilly's concentrated serum.

Spinal fluid findings: Cell count reached 11,200 on the 2nd day; fell to 4,700 on the 4th day; ranged between 3,800 and 4,900, during the serum reaction from the 4th to 8th days (characterized by fever, urticaria, and itching) till the 7th day when it fell to 860; cell count fell rapidly thereafter to 400 on the 8th day and to 100 on the 9th day. No organisms were seen after the 2nd day.

White blood count: Was 28,800 on entrance and was still 18,400 on the 6th day during the serum reaction. No other counts were reported.

Clinical Course: Temperature was 104 on entrance; fell to 98.6 on the 4th day; continued fever subsequently apparently due to serum reaction, for on the 9th day, with recovery from serum reaction, temperature returned to normal and remained so thereafter. Definite clinical improvement noted on 4th day. Patient became totally deaf on the first day of illness and was deaf on entrance; no improvement in hearing during hospital stay. Patient dismissed on 21st day with complete recovery but residual deafness.

DISCUSSION: This case also shows the advisability of frequent spinal drainage over a considerable period of time, combined with intensive administration of serum

for 3 to 5 days, and then discontinuing the serum even though the cell count of the spinal fluid is still high and fever present. In this case, however, the serum was given so intensively at first that a serum reaction developed on the fourth day, but prompt recovery followed when the serum was discontinued. The serum reaction was also reflected in the white blood count and in the spinal fluid cell count.

CONCLUSIONS:

1. The efficacy of serum therapy of meningococcus meningitis varies with the content of specific antibodies contained in the serum against the particular strain of infecting organism.
2. The mortality from epidemic meningitis is apt to be high in the extremes of age.
3. Coincident conditions such as possible nephritis and diabetes should be investigated in all cases of meningococcic meningitis.
4. The institution of treatment early is to be desired.
5. Drainage and serum administration by lumbar puncture only is frequently inadequate.
6. In ~~cases of~~ infants ventricular puncture for drainage and administration of serum should be a valuable procedure, and sometimes is the only route available.

7. Intramuscular injections of serum should be used when intraspinal and intracisternal administration of serum is impossible.

8. Prolonged intensive serum administration frequently produces a meningeal reaction to the foreign protein, and such a reaction may

- a. Retard clinical improvement.
- b. Maintain high fever.
- c. Maintain or aggravate spinal fluid pleocytosis.
- d. Maintain or increase polymorphonuclear preponderance in the spinal fluid.
- e. Possibly be a factor in the production of cerebro-spinal fluid blocks and hydrocephalus.

9. A general serum reaction frequently occurs after intensive serum administration, characterized by fever, leucocytosis, and an urticarial eruption.

10. The disappearance of meningococci from the spinal fluid is a fair indication of the specificity of the serum being used.

11. Drainage is an important factor in the treatment of meningitis.

12. A more or less arbitrary routine of treatment is advocated, consisting of alternate cisternal and lumbar drainage every 12 hours with the administration of serum

each time for 3 to 5 days, after which serum should be discontinued for at least 2 days, and then resumed for a few days if temperature and spinal fluid cell count have not fallen; meanwhile, continuing drainage every 12 to 24 hours.

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APPENDIX

DETAILED CASE REPORTS

CASE 1

A.P., white schoolgirl, age 12.

ADMITTED: November 18, 1930. Hospital days: 4.

ONSET AND DEVELOPMENT: On November 16, 1930 about eight P.M. the patient complained of sore throat, headache, and pain in right shoulder. Later she had a chill, followed by forceful vomiting. Fever at times up to 104 F. Became delirious on November 18th with spasticity and opisthotonos.

FINDINGS ON ENTRANCE: T. 104 F. (R). Throat injection and postnasal discharge. Opisthotonos, neck rigidity, and bilateral Kernig. Spinal fluid: turbid; pressure 22 mm. Hg; cells 6,882; 99% polys; and a few Gram negative diplococci on smear. Blood count: R.B.C. 4,520,000; Hb. 82%; W.B.C. 17,800; 96% polys.

PROGRESS AND TREATMENT:

November 18, 1930: T. reached 105.2 F. twice; R. 150; R. 30; At 3 P.M. 30 cc. Lilly's antimeningococcic serum by lumbar puncture. At 11:30 P.M. 25 cc. of turbid fluid was withdrawn and 15 cc. of serum given by lumbar puncture.

November 19: T. reached 107.2 F. (R); R. 150; R. 40. At 8 A.M. 30 cc. of turbid fluid withdrawn and 15 cc. of serum given by lumbar puncture. At 4 P.M. 40 cc. of fluid withdrawn and 20 cc of serum given by lumbar puncture. At 8 P.M. patient became cyanotic, pulseless, and heart rapid and irregular, and T. 107.2. Caffein sodium benzoate gr. VIss q. 4 hrs. begun. At

CASE I (cont.) and CASE II

10 P.M. 35 cc. of cloudy fluid withdrawn by lumbar puncture and 250 cc. of 10% glucose intravenously.

November 20: T. range 101.2 to 104 F. In A.M. lumbar puncture showed pressure 3 mm. hg. which rose to 18 mm on jugular compression; 18cc. of cloudy fluid removed and 15 cc. of serum given intraspinally. In P.M. 35 cc. of cloudy fluid withdrawn; no serum given by lumbar puncture. Patient quite rigid.

November 21: At 7 A.M. patient died a cardiac and respiratory death. No autopsy secured.

CASE II

E.B.; age 19, white, married, housewife.

ADMITTED: December 2, 1930. Hospital days: 24.

ONSET AND DEVELOPMENT: Dec. 1, 1930 patient, who had had a cold for several days previously, developed pain in back of neck and head, fever, and persistent vomiting. On Dec. 2nd developed neck rigidity and a suggestion of a Kernig.

FINDINGS ON ENTRANCE: T. 104.F (R); P. 140; R. 28.

Physical examination showed irritability, neck rigidity, and retraction, contracted pupils, with no reaction to light, and positive Kernig. Lumbar puncture: fluid under increased pressure; turbid; cells 17,000, predominantly polys; and intracellular Gram negative diplococci seen on smear.

PROGRESS AND TREATMENT:

Dec. 2: Given 10 cc. Lilly's concentrated anti-meningococcic serum by lumbar puncture, with slight reaction, controlled by adrenalin min. X.

CASE II (cont.)

Dec.3: T. 101.5 F.; P. 110; R. 25. Blood count: Hb. 85%; R.B.C. 4,620,000; W.B.C. 18,200; polys 72%. Urinalysis: 1/ albumen. In A.M. given 60 cc. Mulford's serum intravenously, and by cisternal puncture 25 cc. purulent fluid was removed and 15 cc. Lilly's concentrated serum given intracisternally. Cell count of fluid: 9,500. In P.M. by lumbar puncture: 35 cc fluid removed, cell count 12,200, and 25 cc Lilly's concentrated serum intraspinally.

Dec.4: T. 102; P. 120; R. 20. Blood count: 14,600 leucocytes. Urinalysis: 3/ albumen; hyaline and granular casts. In A.M. by cisternal puncture: 35 cc. purulent fluid removed; cells 3,700; chiefly polys; and rare organisms seen on smear. 20 cc. Lilly's concentrated serum intracisternally; 60 cc. Mulford's serum intravenously. Spinal fluid culture positive for meningococci.

Dec.5: T. 102.5; P.120; R. 25. In A.M. by cisternal puncture 30 cc. slightly cloudy fluid removed; cells 685, chiefly polys; no organisms on smear. 20 cc. Lilly's concentrated serum intracisternally. Patient less comatose, responds better. In P.M. by lumbar puncture 35 cc. bloody fluid removed; cells 5,100, many R.B.C.; no organisms on smear. 20 cc. Lilly's concentrated serum intraspinally.

Dec.6: T. 103; P. 120; R. 22. W.B.C. 18,600, 72% polys. In A.M. by cisternal puncture 25 cc bloody fluid removed; cells 5,500; 10 cc. Lilly's concentrated serum

CASE II (cont.)

given intracisternally. Patient improved, responsive, but has involuntary urination. In P.M. by lumbar puncture 35 cc. xanthochromic fluid removed, cells 4,820. 10 cc. Lilly's concentrated serum given intraspinally.

Dec. 7: T. 103; P. 120; R. 22. In A.M. by lumbar puncture 10 cc. xanthochromic fluid removed, ~~pressure~~ cells 4,100; 5 cc. Lilly's concentrated serum given intraspinally. In P.M. 30 cc. cloudy xanthochromic fluid removed, pressure 20 mm. Hg. and rose to 24 on jugular compression; 20 cc. Lilly's concentrated serum given intraspinally.

Dec. 8: T. 102.5; P. 120; R. 22. Patient developed angioneurotic edema at noon, beginning with swelling of lips and involving whole body, the back being least affected. Given adrenalin min. X at 2, 3, 5:30, and 9:30 P.M. Definite improvement after first two doses. Eruption became much worse when a spinal puncture was performed using 1cc. 2% novocain. Lumbar puncture showed cloudy ^{yellow} fluid; pressure 14 mm. Hg., rose to 20 on jugular compression; 5 cc. removed; cells 22,500. Mental condition fairly clear, much improved.

Dec. 9: T. 101; P. 120; R. 20. Definite improvement in neck rigidity and eruption. Atropine given for eruption. By cisternal puncture: 15 cc. almost clear fluid removed; cells 155; no R.B.C.; no organisms; 10 cc. Lilly's concentrated serum intramuscularly.

Dec. 10: T. 101 to 99; P. 100; R. 20. Rash was

CASE 11 (cont.)

slightly exaggerated following intramuscular injection of serum. By lumbar puncture: 30 cc. clear, colorless fluid removed; cells 130. W.S.B.C. 9,200.

Dec.11: T. 99.6; P. 100; R. 20. By lumbar puncture 4 cc. clear fluid obtained; cells 100; pressure 6 mm. Hg., rising to 16 on jugular compression. 10 cc. Lilly's concentrated serum intramuscularly. No rash.

Dec.12: T. 99.6; P. 90; R. 20. Still slightly confused mentally. 10 cc. Lilly's concentrated intramuscularly.

Dec.14: T. 101.2; P. 80; R. 22. No chest or abdominal pathology demonstrable to account for rise in temperature. By lumbar puncture 20 cc. of clear fluid removed; cells 100; pressure 10 mm. Hg., rising to 20 on jugular compression. 10 cc. Lilly's concentrated serum intramuscularly.

Dec.15: T. 103; P. 120; R. 26. Patient complained of sore right eye, but no pathology demonstrable. Neck rigidity very slight. Slight weakness of left leg compared to right. Patient slightly confused. By lumbar puncture 30 cc. slightly cloudy fluid removed; cells 490, chiefly polys; no organisms seen.

Dec.16: T. 99; P. 90; R. 20. Patient rational, memory good. By lumbar puncture 8 cc. slightly cloudy fluid removed.

Dec.17: T.P.R. normal. By lumbar puncture 15 cc. clear fluid removed; cells 110, chiefly polys. 10 cc.

CASE II (cont.) and CASE III

Mulford's unconcentrated serum intramuscularly.

Dec.25: T. normal for past week. Patient has shown gradual improvement; no sequellae. Patient dismissed.

Patient was seen one year later with no apparent residuals from this illness.

CASE III

M.D., colored, female, age 12 years.

ADMITTED: Dec.21,1930. HOSPITAL DAYS: 36.

ONSET AND DEVELOPMENT: On Dec.19,1930 developed fever, headache, vomited several times, and became irrational. Was seen by a physician of Dec.21, who noted neck rigidity, hyperactive reflexes, and delirium.

FINDINGS ON ENTRANCE: T. 104.5; P. 120; R. 24. Neck rigidity, opisthotonos, muttering delirium, restlessness, photophobia. Throat congested, exudate of tonsils, herpes labialis, cervical adenopathy. Knee jerks hyperactive, and positive Kernig and Brudzinski. Lumbar puncture: fluid cloudy; cells 3,000, chiefly polys; Gram negative diplococci seen on smear; 35 cc. fluid removed.

PROGRESS AND TREATMENT:

Dec.21: 30 cc. Mulford's antimeningococcic serum intravenously and 20 cc. Lilly's concentrated serum intraspinally.

Dec.22: T. 103; P. 120; R. 28. Patient restless; involuntary urination. In A.M. by cisternal puncture

CASE III (cont.)

40 cc. cloudy fluid removed; cells 3,500; 20 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 30 cc. turbid fluid removed; cells 6,500; 20 cc. Lilly's concentrated serum intraspinally.

Dec.23: T. 103; P. 120; R. 26. In A.M. by lumbar puncture 30 cc. turbid fluid removed; cells 8,000; 20 cc. Lilly's concentrated serum intraspinally. In P.M. by lumbar puncture 30 cc. fluid removed and 20 cc. Lilly's serum intraspinally.

Dec.24: T. 103; P. 120; R. 28. In A.M. by lumbar puncture 30 cc. cloudy fluid removed; cells 8,200; 20 cc. Lilly's concentrated serum intraspinally. In P.M. same procedure repeated.

Dec.25: T. 103.2; P. 130; R. 28. In A.M. by lumbar puncture 30 cc. fluid removed; cells 7,800; 20 cc. Lilly's concentrated serum intraspinally. In P.M. drainage of 25 cc. by lumbar puncture; no serum.

Dec.26: T. 103.2; P.120; R. 20. In A.M. by cisternal puncture 50 cc. fairly clear fluid removed; cells 1,010; no organisms seen; 10 cc Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 15 cc. fluid withdrawn; 10 cc. Lilly's serum intraspinally.

Dec.27: T. 104; P. 130; R. 28. No clinical improvement. Rigidity more marked. W.B.C. 12,000. In A.M. by cisternal puncture 40 cc. cloudy fluid removed; cells 1,600; 20 cc. Lilly's concentrated serum intracisternally. In P.M. 40 cc. cloudy fluid drained by lumbar puncture; no serum given.

CASE III (cont.)

Dec.28: T. 104.6; P. 124; R. 28. Given 1,000 cc. tap water by proctoclysis. In A.M. by lumbar puncture 30 cc. slightly cloudy fluid removed; 20 cc. Lilly's concentrated serum intraspinally. In P.M. by lumbar puncture 40 cc. cloudy fluid removed, cells 5,100; no serum.

Dec.29: T. 101.2; P. 120; R. 24. W.B.C. 17,800 with 89% polys. Given 1,200 cc. tap water by proctoclysis. In A.M. 50 cc. cloudy fluid removed by lumbar puncture; cells 1,400; 60 cc. Mulford's unconcentrated serum intravenously. In P.M. 50 cc. cloudy fluid drained by lumbar puncture; no serum intraspinally.

Dec.30: T. 105; P. 140; R. 28. Given 900 cc. tap water by proctoclysis. In A.M. by lumbar puncture 40 cc. clear fluid removed; cells 490; 92% polys; no organisms seen. Culture negative. 15 cc. Parke Davis' unconcentrated serum intraspinally. In P.M. by lumbar puncture 25 cc. cloudy fluid removed; cells 3,700; 15 cc. Parke Davis' serum intraspinally.

Dec.31: T. 101.2; to 103.6; P 120 to 140; R. 28. W.B.C. 15,200 with 93% polys. Given 2,450 cc. tap water by proctoclysis. In A.M. by lumbar puncture 50 cc. cloudy fluid removed; cells 3,700; 15 cc. Parke Davis' serum intraspinally. In P.M. 30 cc. cloudy fluid drained by lumbar puncture, cells 5,150; no serum.

Jan.1,1931: T. 102.5 to 99.8; P. 120; R. 24. Given 2,500 cc. tap water by proctoclysis. In A.M. by lumbar puncture 20 cc. cloudy fluid removed, cells 7,400.

CASE III (cont.)

In P.M. 30 cc. cloudy fluid removed by lumbar puncture, cells 1,600; 15 cc. Parke Davis' serum intraspinally. No clinical improvement.

Jan.2: T. 103; P.100; R. 24. Given 3,000 cc. tap water by proctoclysis. W.B.C. 14,000. In A.M. by lumbar puncture 30 cc. cloudy fluid removed; cells 5,200; no organisms seen; culture negative. In P.M. by lumbar puncture 40 cc. cloudy fluid removed; cells 1,200; 15 cc. Mulford's serum intraspinally.

Jan.3: T. 103 to 99; P. 100; R. 24. Given 4,250 cc. tap water by proctoclysis. Patient has a cough with occasional expectoration of small quantity of blood. Interne decided this was of post-nasal origin and could find no signs of pneumonia. In A.M. by lumbar puncture 40cc. cloudy fluid removed; cells 5,500; no serum given. In P.M. by lumbar puncture 20 cc. slightly cloudy fluid removed; cells 650; no organisms seen; no serum given.

Jan.4: T. 98 to 99.8; P. 90; R. 20. Given 1,500 cc. tap water by proctoclysis. W.B.C. 9,100. Drainage by lumbar puncture of 40 cc. xanthochromic fluid; cells 1,780. (T.R.R. normal throughout rest of hospital stay).

Jan.5: Opisthotonos less. 50 cc. xanthochromic fluid removed by lumbar puncture; cells 210. Notation by interne: "Think this is a case of too much serum."

Jan.6: Lumbar puncture: 15 cc. fluid removed; cells 930.

Jan.7: Lumbar puncture: 35 cc. clear fluid removed; cells 133. Less neck rigidity. Increasing fluid intake.

CASE III (cont.) and CASE IV
Patient improving.

Jan.8: Lumbar puncture: 30 cc. clear fluid removed;
cells 470; pressure normal.

Jan.9: Lumbar puncture: 40 cc. slightly cloudy xan-
thochromic fluid removed; cells ~~570~~. 880.

Jan.10: Lumbar puncture: 25 cc. slightly xanthochro-
mic fluid removed; cells 370.

Jan.11: Lumbar puncture: 40 cc. slightly cloudy
xanthochromic fluid removed; cells 1,250.

Jan. 12: Lumbar puncture: 40 cc. cloudy xanthochro-
mic fluid removed; cells 1,650.

Jan.13: Notation by Dr.A.E.Bennett: "Condition
much improved. Believe that sterile meningeal reaction
is responsible for advanced cell count."

Jan.14: Lumbar puncture: 20 cc. fairly clear fluid
removed; cells 300; pressure 14 mm hg. rising to 22 on
jugular compression and falling to 8 after drainage.

Jan.15: W.B.C. 7,300 with 72%polys.

Jan.16: Lumbar puncture: 30 cc. clear fluid removed;
cells 240; no organisms seen; 60% lymphs. and 40% polys.

Jan.23: Patient gradually feeling stronger. No
abnormal neurological findings.

Jan.25: Patient dismissed.

CASE IV

E.J., white, male, age 59 years, farmer by occupation.
ADMITTED: Jan.8,1931. HOSPITAL DAYS: 2.
ONSET AND DEVELOPMENT: Patient ~~had~~ had urinary retention
for some time and had been sluggish and inactive since

CASE IV (cont.)

November 1930. On Jan. 1, 1931 patient vomited, had a chill lasting 15 minutes, complained of pain in head, and became irrational.

FINDINGS ON ENTRANCE: In coma from which could be roused with difficulty; pupils contracted; abdomen distended and pain on pressure over lower abdomen; reflexes normal. T. 98 (R); P. 70; R. 15. Blood count: Hb. 99%; R.B.C. 5,100,000; W.B.C. 7,800 with 89% polys. Urinalysis: 3/ albumen, 1/ hyaline casts, 3/ granular casts. N.F.N. 62.2%. Creatinine 1.7mg%. A diagnosis of urinary retention was made on entrance at 8:40 A.M. Jan. 8.

PROGRESS AND TREATMENT:

Jan. 8: T. 101; P. 80; R. 20. At 11:15 A.M. Reflexes hyperactive, Kernig and Brudzinski positive. Lumbar puncture: pressure 17 mm. Hg. rising to 27 on jugular compression; fluid yellow and purulent; cells 6,200; numerous Gram negative intracellular diplococci seen on smear. Diagnosis changed to meningococcus meningitis. At 2 P.M. by cisternal puncture: 30 cc. turbid yellow-green fluid removed; 20 cc. Lilly's concentrated antimeningococcic serum given intracisternally. 60 cc. Mulford's unconcentrated serum intravenously. Patient delirious.

Jan. 9: T. 102; P. 90; R. 28 during A.M. Patient would mumble responses. At 2:30 P.M. by cisternal puncture 20 cc. yellow cloudy fluid removed and 20 cc. Lilly's concentrated serum given intracisternally. 1,000 cc. normal saline solution, 200 cc. 10% glucose solution, and

CASE IV (cont.) and CASE V

7 gr. sodium amytal given intravenously. At 7:30 P.M. T. rose to 103.2; condition apparently unchanged otherwise. At 11:30 P.M. the temperature reached 105.2; patient restless; respirations and pulse irregular.

Jan. 10: At 4 A.M. temperature 107. At 10:30 A.M. patient died a respiratory and cardiac death. No autopsy obtained.

CASE V

J.S., white, female, age 4 years.

ADMITTED: March 4, 1931. HOSPITAL DAYS: 65.

ONSET AND DEVELOPMENT: March 1, 1931: fever, listlessness, later restlessness. Had had slight upper respiratory infection for past week. March 2: vomited. March 3: developed stiff neck, and some opisthotonos. Seen by Dr. A. E. Bennett who gave 30 cc. antimeningococcic serum intraspinally. (Patient had previous history of falling down stairs and fracturing skull 2 years before. Was ill with excessive vomiting for 3 days at that time. Not very ill after the 4th day.)

FINDINGS ON ENTRANCE: Semi-comatose, neck rigidity, opisthotonos, positive Kernig, Brudzinski, and Babinski. Tonsils hypertrophied and inflamed, post-nasal discharge, and enlarged cervical lymph nodes.

PROGRESS AND TREATMENT:

March 5: T. 103; P. 140; R. 28. W.B.C. 26,000, 86% polys. Given 1,500 cc. tap water by proctoclysis. At 12:15 A.M. by lumbar puncture 10 cc. purulent fluid

CASE V (cont.)

removed, and 10 cc. Lilly's concentrated serum given intraspinally. At 11:45 A.M. by lumbar puncture 20 cc. very cloudy fluid removed; pressure 30 mm. hg.; cells 25,600, 97% polys; many Gram negative intracellular diplococci seen on smear; cultures negative for meningococci; 15 cc. Parke Davis' serum intraspinally. At 8 P.M. by cisternal puncture 30 cc. purulent fluid removed, and 10 cc. Lilly's concentrated serum given intracisternally.

March 6: T. 103.2; P. 130; R. 60. Given 1,500 cc. tap water and 1,000 cc. 5% glucose solution by proctoclysis. In A.M. by lumbar puncture 25 cc. turbid fluid removed; cells 17,400; a few organisms seen on smear; cultures negative; 15 cc. Parke Davis' serum intraspinally. In P.M. by cisternal puncture 20 cc. dark cloudy fluid removed; and by lumbar puncture 10 cc. dark cloudy fluid removed; and 10 cc. Lilly's concentrated serum given intraspinally.

March 7: T. 100.8 to 104.8; P. 130; R. 60. Given 1,200 cc. tap water and 500 cc. 5% glucose by proctoclysis. In A.M. by lumbar puncture 10 cc. bloody fluid removed, and 10 cc. Lilly's concentrated serum intraspinally. In P.M. by lumbar puncture 32 cc. bloody fluid removed, and 15 cc. Parke Davis' serum intraspinally.

March 8: T. 104.4; P. 140; R. 50. Given 3,700 cc. tap water and 5% glucose by proctoclysis. In A.M. by lumbar puncture 32 cc. bloody fluid removed; cells 7,200; 20 cc. Lilly's concentrated serum intraspinally. Patient vomited repeatedly, and had abdominal distention. In P.M.

CASE V (cont.)

by lumbar puncture 30 cc. fluid removed, and 15 cc. Parke Davis' serum intraspinally.

March 9: T. 103; P. 140; R. 35. General condition improved. Given 200 cc. tap water by proctoclysis. In A.M. by cisternal puncture 17 cc. yellow fluid removed; 10 cc. Lilly's concentrated serum intracisternally. Blood count: Hb. 96%; R.B.C. 5,160,000; W.B.C. 23,200 with 72% polys. In P.M. by lumbar puncture 12 cc. blood tinged fluid removed; few organisms seen on smear. 10 cc. Lilly's concentrated serum intraspinally.

March 10: T. 103; to 100; P. 120; R. 30. Given 600 cc. tap water and 5% glucose by proctoclysis. In A.M. by cisternal puncture 40 cc. yellow cloudy fluid removed; cells 6,200, 94% polys; no organisms seen; culture negative; 15 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 15 cc. cloudy fluid removed; 10 cc. Mulford's unconcentrated serum intraspinally.

March 11; T. 100 to 103; P. 130; R. 32. Patient much improved. In A.M. by cisternal puncture 50 cc. bloody fluid removed; 10 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 40 cc. cloudy fluid removed; cells 2,700; no organisms seen; culture negative; 25 cc. Mulford's serum intraspinally.

March 12: T. 101.4 to 100; P. 130; R. 28. Blood count: 22,000 leucocytes, 86% polys. In A.M. by cisternal puncture 35 cc. clear fluid removed; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar puncture 22 cc. cloudy fluid removed; cells 2,100; 10 cc.

CASE V (cont.)

Lilly's concentrated serum intraspinally.

March 13: T. 100; P. 120; R. 30. In A.M. by lumbar puncture 25 cc. fairly clear fluid removed; cells 2,900; predominance of polys.; 15 cc. Mulford's serum intraspinally.

March 14: T. 99 to 100; P. 100; R. 20. By lumbar puncture 20 cc. cloudy fluid removed; 15 cc. Parke Davis' serum intraspinally.

March 15: T. 103; P. 100; R. 24. By lumbar puncture 25 cc. slightly cloudy fluid removed; 15 cc. Mulford's serum intraspinally.

March 16: T. 100 to 102; P. 100 to 130; R. 20 to 40. By lumbar puncture 20 cc. cloudy fluid removed; cells 1,278, polys predominating; 15 cc. Parke Davis' serum intraspinally.

March 17: T. 101; P. 110; R. 20. W.B.C. 7,200. By lumbar puncture 30 cc. slightly cloudy fluid removed; cells 1,420, 97% polys.; no organisms seen; 15 cc. Mulford's serum intraspinally.

March 18: T. 99; P. 120; R. 20 to 30. Patient irritable, vomiting repeatedly, shows exophthalmos, and is apparently deaf. By cisternal puncture 40 cc. clear fluid removed; cells 180; 69% polys.; no organisms seen; 7.5 cc. Mulford's serum intracisternally.

March 19: (T. throughout rest of hospital stay normal; P. and R. irregular.) By lumbar puncture 20 cc. clear fluid removed; cells 128, ^{lymphs 61%,} polys 39%; no organisms.

March 20:

CASE V (cont.) and CASE VI

March 20: Patient had projectile type of vomiting.
No spinal taps done.

March 24: By cisternal and lumbar punctures fluid clear;
cells 6 and 20 respectively.

March 26: Blood count: Hb. 96%; R.B.C. 5,140,000;
W.B.C. 10,000; polys 53%.

March 30: Marked improvement in past week. Was put
on hydriotic acid with apparently beneficial results.
Recognizes friends, but does not hear.

April 2: Blood count: Hb. 85%; R.B.C. 4,650,000;
W.B.C. 9,800; polys 66%.

April 7: Encephalogram shows both lateral ventricles
to be markedly dilated, and subarachnoid spaces obliterated.
Patient on strict dehydration routine, fluids restricted
to less than 500 cc. daily.

April 8: to May 7: Lumbar punctures have been done
daily, or every other day, to relieve pressure which
ranged between 10 and 46 mm. Hg.; between 20 and 60 cc.
fluid removed each time.

May 8: Patient dismissed in static condition to be
followed in dispensary. Complete bilateral deafness,

CASE VI

J.G., colored, female, age 12 years.

ADMITTED: March 9, 1931. HOSPITAL DAYS: 70.

ONSET AND DEVELOPMENT: On March 6 developed acute coryza
with sore throat. On the 7th complained of pain in left
eye and later of marked frontal headache; and towards

CASE VI (cont.)

evening neck, legs, and abdomen became sore and stiff. Was restless and irritable. On the 8th: high fever and delirium. Seen by an outcall student on the 9th and brought to hospital.

FINDINGS ON ENTRANCE: Neck rigidity and retraction of head. Positive Kernig and Brudzinski. Pharynx inflamed; post-nasal discharge. Tonsils hypertrophied. T.102; P.100; R.28.

PROGRESS AND TREATMENT:

March 9: Lumbar puncture: pressure 22 mm. Hg.; fluid cloudy; cells 6,700; preponderance of polys; but no meningococci on smear. 15 cc. Parke Davis' antimeningococcic serum intraspinally.

March 10: T.102; P.90; R.40. Blood count: Hb. 82%; R.B.C. 4,860,000; W.B.C. 26,500; 90% polys. Patient irritable; complained of headache. In A.M. by cisternal puncture 30 cc. cloudy fluid removed; cells 5,600, 95% polys; a few Gram negative intracellular diplococci; culture negative; 15 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 25 cc. fluid removed and 15 cc. Mulford's serum intraspinally.

March 11: T.100.5; P.80 to 120; R. 30. In A.M. by cisternal puncture 20 cc. cloudy fluid removed; cells 7,800; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar puncture 32 cc. cloudy fluid removed; cells 5,200; one diplococcus seen on smear; culture negative; 15 cc. Mulford's serum and 5 cc. Lilly's serum intraspinally.

CASE VI (cont.)

March 12: T.101; P.100; R.20. Blood count: 25,200 W.B.C., 90% polys. In A.M. by cisternal puncture 34 cc. fluid removed; cells 3,860.; 20 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 25 cc. cloudy fluid removed and 15 cc. Mulford's serum intraspinally.

March 13: T.100; P.100; R.20. In A.M. by lumbar puncture 30 cc. fluid removed; cells 2,300; 15 cc. Mulford's serum intraspinally. In P.M. by lumbar puncture 25 cc. slightly yellow fluid removed; 15 cc. Lilly's concentrated serum intraspinally.

March 14: T.101.5; P.120; R.20. In A.M. by lumbar puncture 15 cc. slightly cloudy fluid removed; 15 cc. ^{Parke Davis'} ~~Lilly's concentrated~~ serum intraspinally. In P.M. by lumbar puncture 20 cc. cloudy fluid removed; cells 13,500; 15 cc. Mulford's serum intraspinally.

March 15: T.101; P.130; R.20. In A.M. by lumbar puncture 25 cc. cloudy fluid removed; cells 1,500; no organisms seen after centrifuging; 15 cc. Mulford's serum intraspinally. In P.M. by cisternal puncture 12 cc. cloudy fluid removed and 10 cc. Lilly's concentrated serum intracisternally.

March 16: T.102; P.120; R.24. By lumbar puncture 34 cc. slightly cloudy fluid removed; cells 1,370; 15 cc. Lilly's concentrated serum intraspinally.

CASE VI (cont.)

March 17: T.101; P.100; R.30. Blood count: 24,800 W.B.C. In A.M. by lumbar puncture no fluid obtained. In P.M. by cisternal puncture 35 cc. clear fluid removed; cells 640; some diplococci seen but not intracellularly; 30 cc. Mulford's serum intracisternally.

March 18: T.101; P.120; R.24. By cisternal puncture 20 cc. slightly cloudy fluid removed; cells show 60% polys and 40% lymphs; several diplococci seen on smear; 15 cc. Mulford's serum intracisternally.

March 19: T.100.6 to 103.2; P.120; R.30. Blood count: 14,000 W.B.C., 84% polys. At 10:30 A.M. by cisternal puncture 45 cc. clear fluid removed; pressure very high; cells 400; 42% polys, 58% lymphs; no organisms seen in smear; 15 cc. Parke Davis' serum intracisternally. Patient developed a severe pain in head and legs, causing her to scream, within half an hour after the cisternal puncture; had a chill at 4:15 P.M. and temperature rose to 103.2. Headache persisted till 7 P.M. when temperature had fallen to 102.4.

March 20: T.101.5; P. 120; R. 26. By cisternal puncture 35 cc. slightly cloudy fluid removed; cells 720; no organisms seen; predominance of lymphs; 15 cc. Mulford's serum intracisternally.

March 21: T. 103; P.140; R.24. By cisternal

CASE VI (cont.)

puncture 22 cc. clear fluid removed; cells 418; 10 cc. Mulford's serum intracisternally.

March 22: T.102.8; P.140; R.24. By cisternal puncture 12 cc. cloudy fluid removed; very little pressure; cells 1,340; predominance of polys; 15 cc. Parke Davis' serum intracisternally. By lumbar puncture no fluid obtained.

March 24: T.101.5; P.130; R.26. By lumbar puncture no fluid obtained. By cisternal puncture 35 cc. clear fluid removed; cells 120; predominance of lymphs; pressure high; no serum.

March 25: T.100 to 104; P.160; R.24 to 40. Blood count: Hb. 74%; R.B.C. 4,205,000; W.B.C.12,200; polys 79%. At 11 A.M. by cisternal puncture 30 cc. clear fluid removed; pressure slightly increased; cells 587; predominance of polys; 10 cc. Lilly's concentrated serum intracisternally. Within half an hour after the cisternal puncture, patient became irritable and cried with headache. At noon T.100. At 2:30 P.M. developed pain in the abdomen and muscular twiviverings. At 4 P.M. temperature rose to 103.4. At 7:30 P.M. lumbar puncture attempted and no fluid obtained. Patient still in great pain. At 8 P.M. temperature reached 104; patient very restless. At midnight T.102.2, pulse slightly irregular.

March 26: T.103.4; P.150; R.28. Blood count: Hb. 82%; R.B.C. 5,480,000; W.B.C. 14,600; polys 89%.

CASE VI (cont.)

At 11:30 A.M. by cisternal puncture 18 cc. clear fluid removed; 15 cc. Parke Davis' serum intracisternally. Patient again developed a severe headache in the afternoon. At 7 P.M. an urticarial eruption appeared on the arms, muscular twitching, and rapid thready pulse. Patient given adrenalin min. ii at 7 and 8 P.M. with improvement.

March 27: T.102; P.140; R.28. By lumbar puncture 30 cc. cloudy xanthochromic fluid removed; cells 6,720; polys 50%; lymphs 50%; no organisms seen; pressure increased.

March 28: T.100; P.126; R.24. By cisternal puncture 30 cc. cloudy fluid removed.

March 29: T.100.2; P.122; R.26. By cisternal puncture 30 cc. xanthochromic fluid removed.

March 30: T.99.6; P.128; R.24. By cisternal puncture 35 cc. slightly cloudy fluid removed; slightly increased pressure; cells 220; lymphs predominating.

March 31: T.100; P.110. (R. normal for the rest of hospital stay.) By cisternal puncture 40 cc. clear fluid removed; cells 320; lymphs predominating; pressure slightly increased.

April 2: Blood count: Hb. 85%; R.B.C. 4,106,000; W.B.C. 10,600.

April 4: T.100; P.100 to 120; By cisternal puncture 30 cc. clear fluid removed.

CASE VI (cont.)

April 8: T.99 to 100.8; P.90 to 120. By cisternal puncture 4 cc. clear fluid removed; pressure 8 mm. Hg.

April 11: T.98 to 99; P. 90 to 100. Complains of headache and neck pain. Vomited following each meal.

April 12: T.99; P.90 to 100. Complains of pain in back of neck and has some head retraction; is very irritable, but shows no signs of hydrocephalus. Mentally clear and alert.

April 16: (T. and P. normal for rest of hospital stay.) Patient shows signs of hydrocephalus. Is on dehydration routine, fluids being restricted to less than 500 cc. daily.

April 19: Patient has neck retraction; vomits almost every meal. Silly reaction and flight of ideas during past 3 or 4 days. By lumbar puncture ~~100x~~ 10 cc. clear fluid removed; pressure 20 mm. Hg., slowly rising to 40 mm. Hg. on jugular compression.

April 23: Patient shows better response and orientation. By lumbar puncture 40 cc. clear fluid removed; pressure 18 mm. Hg.; cells 75, all lymphs.

April 24: Encephalogram done: 80 cc. of fluid replaced by air. Some vomiting during the rest of day. Report: "Encephalogram shows moderate internal hydrocephalus with obliteration of the subarachnoid spaces."

~~April 25: Nausea and vomiting at intervals.
Reverts back to former level and~~

CASE VI (cont.) and CASE VII

April 25: Nausea and vomiting at intervals. Reverts back to former manic and confused ~~state~~ mental reaction. Neck rigidity and retraction more marked.

April 26: Partial enuria for past 2 days. By lumbar puncture 30 cc. fluid removed; pressure 10 mm. hg.; cells 850. Opinion noted by interne: "Nausea and vomiting must be on basis of arachnoiditis secondary to air injection."

May 5: Nausea and vomiting continued. Urinary output again reduced. By lumbar puncture 18 cc. clear fluid removed; pressure not increased.

May 10: By lumbar puncture 25 cc. clear fluid removed; pressure 12 mm. hg.; cells 125.

May 12: Increased neck retraction. Nausea and vomiting continue.

May 15: Little change noted. Patient seems somewhat brighter.

May 17: Patient dismissed. Referred to be followed in dispensary.

CASE VII: G. J., colored, male, age 29 months.

ADMITTED: March 23, 1931. HOSPITAL DAYS: 45.

ONSET AND DEVELOPMENT: On March 20, 1931 patient developed a slight cold with coryza, but no temperature. On the 21st became irritable in the evening and vomited, and complained of head pain. On the 22nd showed head retraction.

FINDINGS ON EXAMINATION:

CASE VII (cont.)

FINDINGS ON ENTRANCE: T.102.6; irritable, slight neck rigidity and head retraction with pain on flexion of neck; slight lateral nystagmus; nasal and post-nasal discharge; tonsils hypertrophied; coarse rales in both lungs; no evidence of consolidation; reflexes exaggerated; positive Kernig.

PROGRESS AND TREATMENT:

March 23: T.104.8. Blood count: hb. 77%; R.B.C. 3,700,000; W.B.C. 17,950; polys 87%. By lumbar puncture 15 cc. cloudy fluid removed; cells 5,330; polys 89%; Gram negative intracellular diplococci seen on smear; culture positive for meningococcus; pressure 9 mm. Hg. rising to 11 mm. on jugular compression. Given 10 cc. Lilly's concentrated antimeningococcic serum intraspinally and 30 cc. Mulford's unconcentrated serum intravenously.

March 24: T.103.2; P. 140; R.42. In A.M. by cisternal puncture 40 cc. cloudy fluid removed; cells 5,840; polys predominant; some organisms seen; pressure slightly increased; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 15 cc. cloudy fluid removed and 15 cc. Mulford's serum intraspinally.

March 25: T.104; P.112; R.25. In A.M. by cisternal puncture 36 cc. cloudy fluid removed; cells 3,400; polys predominant; a few organisms seen; 10 cc. Lilly's concentrated serum intracisternally.

CASE VII (cont.)

In P.M. by lumbar puncture 30 cc. purulent fluid removed and 15 cc. Mulford's serum intraspinally.

March 26: T.104.4; P.160; R.38. Blood count: Hb. 83%; R.B.C. 4,300,000; W.B.C. 7,200; polys 52%. In A.M. by cisternal puncture 27 cc. slightly cloudy fluid removed; cells 3,640; 80% polys; a few organisms seen; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 40 cc. cloudy fluid removed and 10 cc. Lilly's concentrated serum intraspinally.

March 27: T.103.6; P.148; R.44. In A.M. by cisternal puncture 30 cc. slightly cloudy fluid removed; cells 2,800; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 20 cc. cloudy fluid removed and 15 cc. Mulford's serum intraspinally.

March 28: T.102.4; P.148; R.24. Blood ~~XXXXX~~ Wassermann 4 plus. In A.M. by cisternal puncture 12 cc. cloudy fluid removed and 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 8 cc. thick bloody fluid removed; 10 cc. Mulford's serum intraspinally.

March 29: T.103; P.140; R.30. In A.M. by cisternal puncture 30 cc. slightly cloudy fluid removed; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 30 cc. cloudy fluid removed; 10 cc. Lilly's concentrated serum intraspinally.

CASE VII (cont.)

March 30: T.103.2; P.140; R.36. In A.M. by cisternal puncture 20 cc. slightly cloudy fluid ~~xxx~~ removed; cells 1,100; 69% polys; no organisms seen; 10 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 30 cc. clear fluid removed; 15 cc. Mulford's serum intraspinaly.

March 31: T.103; P.140; R.40. In A.M. by cisternal puncture 28 cc. cloudy fluid removed; cells 1,310; polys predominant; no organisms; 15 cc. Parke Davis' serum intracisternally. In P.M. by ~~ix~~ lumbar puncture 45 cc. cloudy fluid removed and 15 cc. Mulford's serum intraspinaly.

April 1: T.103.4; P.136; R.36. In A.M. by cisternal puncture 20 cc. cloudy fluid removed; cells 1,400; 10 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 15 cc. cloudy fluid removed; 15 cc. Mulford's serum intraspinaly.

April 2: T.101.6; P.120; R.28. Blood count; Hb. 78%; R.B.C. 4,370,000; W.B.C. 10,300; In A.M. by cisternal puncture 30 cc. fluid removed; cells 990; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 30 cc. cloudy fluid removed; 10 cc. Lilly's concentrated serum intraspinaly.

April 3: T.101.4; P.132; R.26. In A.M. by cisternal puncture 25 cc. slightly cloudy fluid removed; cells 780; lymphs and polys equal; no

CASE VII (cont.)

organisms; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar puncture 30 cc. clear fluid ~~xx~~ removed; 15 cc. Mulford's serum intraspinally.

April 4: T.99.2 to 102; P.134; R.30. Patient vomited, increased neck rigidity, comatose. By cisternal puncture 35 cc. clear fluid removed; cells 487; lymphs and polys equal; 15 cc. Mulford's serum intracisternally.

April 5: T.99.2 to 103; P.138; R.30. By ~~six~~ ~~xxxxx~~ lumbar puncture 35 cc. clear fluid removed; cells 194; lymphs predominant; no organisms seen; 15 cc. Lilly's concentrated serum intraspinally. Patient developed Cheyne-Stokes respirations, irregular pulse, and coma. Was given 90 cc. of 50% glucose solution intravenously, adrenalin min. ii subcutaneously, and caffein sodium benzoate gr. iiiss with marked improvement.

April 6: T.99 to 100.4; P.124; R.24. Patient about same. Eyes suggest hydrocephalus. Respirations and heart regular. Low fluid intake started.

April 8: (T. and R. normal from here on for rest of hospital stay; P. ranging between 80 and 120 subject to sudden marked variations.) 30 cc. clear fluid removed by lumbar puncture.

April 9: By lumbar puncture 50 cc. clear fluid removed; pressure high.

April 11: By lumbar puncture 30 cc. clear fluid removed.

April 13: By lumbar puncture 30 cc. clear fluid removed.

CASE VII (cont.)

April 14: Blood count: Hb. 70%; R.B.C. 4,380,000; W.B.C. 5,900; polys 60%. By lumbar puncture 40 cc. clear fluid removed; pressure 52 mm. Hg., falls rapidly.

April 15: Went into coma and collapse, with weak irregular pulse in A.M.; given 25 cc. of 50% glucose intravenously with prompt response. By lumbar puncture 20 cc. clear fluid removed.

April 16: Shows definite evidences of hydrocephalus. By lumbar puncture 45 cc. clear fluid removed.

April 17: By lumbar puncture 52 cc. blood tinged fluid removed.

April 18: By lumbar puncture 12 cc. xanthochromic fluid removed; pressure 20 mm. Hg. falling to 5 mm. on drainage.

April 19: By lumbar puncture 16 cc. straw colored fluid removed; pressure 12 mm. Hg.

April 20: General condition the same. By lumbar puncture 40 cc. straw colored fluid removed; pressure 10 mm. Hg.

April 22: By lumbar puncture 40 cc. clear fluid removed; pressure 20 mm. Hg.

April 23: By lumbar puncture 40 cc. clear fluid removed; pressure 20mm. Hg.; cells 5 lymphs.

April 24: Encephalogram: 60 cc. clear fluid replaced by air. Report: "Encephalogram shows dilated lateral ventricles and obliteration of sub-

CASE VII (cont.) and CASE VIII
arachnoid spaces over cortex." In good condition
following encephalogram; no reaction.

~~April~~ April 28: By lumbar puncture 30 cc. clear
fluid removed; pressure 30 mm. hg.

~~May~~ 14: By lumbar puncture 20 cc. clear fluid
removed; pressure 10 mm. hg.

May 5: Blood count: Hb. 80%; R.B.C. 4,400,000;
W.B.C. 6,200; polys 60%.

May 7: By lumbar puncture 45 cc. clear fluid
removed. Since encephalogram pulse rate has been
more or less stable, ranging between 80 and 90.
General condition improved. No sensory or motor
sequellae. Patient dismissed.

CASE VIII

E.W., colored, male, age 15 months.

ADMITTED: March 26, 1931. HOSPITAL DAYS: 9.

ONSET AND DEVELOPMENT: On March 22 patient developed
high temperature and evidence of an acute upper
respiratory infection; was drowsy. On the 24th an
outcall student was called and noted suspicious
signs of pathology in right lung. On the 25th nys-
tagmus and twitchings were noticed, and temperature
rose from 99 to 104.5.

FINDINGS ON ENTRANCE: Neck rigidity but no head
retraction; nasal discharge; paralysis of lateral
rectus muscle of left eye; increased fremitus at
right base; many coarse rales in both lungs; no Ker-
nig; reflexes exaggerated; positive Babinski.

CASE VIII (cont.)

PROGRESS AND TREATMENT:

March 26: T.104; P.160; R.30. W.B.C. 17,200; 84% polys. By lumbar puncture 42 cc. cloudy fluid removed; pressure 22 mm. Hg.; cells 1,190, polys 92%; many Gram negative intracellular diplococci seen on smear; 10 cc. Lilly's concentrated antimeningococcic serum intraspinally.

March 27: T.103.5; P.172; R.50. In A.M. by cisternal puncture 36 cc. cloudy fluid removed; cells 3,700; organisms seen on smear; culture positive for meningococcus; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 12 cc. very cloudy fluid removed and 12 cc. Mulford's serum intraspinally.

March 28: T.103; P.160; R.35. In A.M. by cisternal puncture 25 cc. cloudy fluid removed; cells 2,400, predominately polys; no organisms seen; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 20 cc. cloudy fluid removed; 15 cc. Mulford's serum intraspinally.

March 29: T.104.2; P.160; R.40. In A.M. by cisternal puncture 14 cc. cloudy fluid removed; 10 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 20 cc. cloudy fluid removed; 15 cc. Parke Davis' serum intraspinally.

March 30: T.104; P.160; R.70. In A.M. by cisternal puncture 30 cc. cloudy fluid removed; cells 2,940, polys predominant; a few organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar

CASE VIII (cont.)

puncture 15 cc. yellow purulent fluid removed; 15 cc. Parke Davis' serum intraspinally. Physical examination revealed some evidences of pneumonia in right lung. X-ray of chest ordered.

March 31: T.103.6; P.146 to 160; R.50. In A.M. by cisternal puncture 28 cc. cloudy fluid removed; cells 2,860; 10 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture 40 cc. cloudy fluid removed; 15 cc. Mulford's serum intraspinally,

April 1: T.103; P.172 to 160; R.20 to 70. Blood count: Hb. 80%; R.B.C. 4,750,000; W.B.C. 16,000. In A.M. by cisternal puncture 15 cc. cloudy fluid removed; cells 2,650; no organisms seen; pressure slightly increased; 15 cc. Parke Davis' serum intracisternally. In P.M. by lumbar puncture 45 cc. yellow cloudy fluid removed; 10 cc. Lilly's concentrated serum intraspinally. X-ray of chest report: "Inflammatory reaction involving right hilar glands with slight infiltration of right upper lobe. Findings consistent with, although not positively indicative of tuberculosis."

April 2: T.103; P.140; R.30; In A.M. by cisternal puncture 25 cc. slightly cloudy fluid removed; cells 2,000, polys predominant; slightly increased pressure; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar puncture 35 cc. cloudy fluid removed; 10 cc. Lilly's concentrated

CASE VIII (cont.) and CASE IX

serum intraspinally.

April 3: T.102.8 to 101; P.140 to 160; R.40 to 50 to 8 to 0. In A.M. by cisternal puncture 30 cc. cloudy fluid removed; cells 3,100, polys predominant; no organisms seen; pressure slightly increased; 15 cc. Parke Davis' serum intracisternally. At 7 P.M. respirations became gasping and stopped. heart stopped beating at 7:03 P.M. Death of "medullary type".

AUTOPSY REPORT: 1. Medullary meningitis.

2. Right lung--some congestion posteriorly.

CASE IX

A.S., white, female, married, age 48 years.

ADMITTED: April 15, 1931. HOSPITAL DAYS: 21.

ONSET AND DEVELOPMENT: Patient had had more or less constant headaches for 6 months prior to entrance, but on April 12th headache became very severe and diplopia developed. On the 13th non-projectile vomiting developed and petechia appeared over legs to hips. Patient became comatose. Was taken to a local hospital where following findings were reported: T.99; P.70; B.P.126/80. Urine: 4/ sugar and trace of acetone and albumen. Spinal puncture : 6 mm. hg. pressure; cells 115; and a few Gram negative diplococci. W.B.C. 1.700 (?), 95% polys. On the 14th urine showed 4/ sugar. Small dose of insulin at 10 A.M. At 3 P.M. sugar 2/. T.97.6; P.60 to 75. No neck rigidity; no Kernig. Patient transferred to University Hospital on the 15th.

CASE IX (cont.)

FINDINGS ON ENTRANCE: No neck rigidity; B.P.130/80; T.98; P.60; R.20. Irrational and stuporous. Urine: 1/ albumen and 1/ sugar. Diagnosis withheld.

PROGRESS AND TREATMENT:

April 16: T.100; P.80; R.24. Patient restless; neck rigidity present; no Kernig; maculo-papular eruption noted on legs to knees. Urine: 2/ albumen and 3/ sugar, 2/ acetone, no casts, occasional R.B.C. and 4 to 6 W.B.C. per high power field. Blood sugar: 151 mg.%. At 3 P.M. by lumbar puncture 5 cc. cloudy fluid removed; pressure 28 mm. Hg.; cells 8,000, mostly polys; many Gram negative intracellular diplococci seen on smear; culture positive. Diagnosis of epidemic meningitis made. Blood count: Hb. 81%; R.B.C. 4,630,000; W.B.C. 15,500; polys 91%. At 9 P.M. by cisternal puncture 32 cc. cloudy fluid withdrawn; 30 cc. Mulford's antimeningococcic serum intracisternally.

April 17: T.99.4; P.70 to 85; R.26. Blood sugar: 126 mg.%. In A.M. by lumbar puncture 20 cc. purulent fluid removed; culture positive for meningococcus; 15 cc. serum intraspinally. In P.M. by cisternal puncture 27 cc. purulent fluid removed; 20 cc. Lilly's concentrated serum intracisternally.

April 18: T.101; P.70; to 85; R.20. Given 1,000 cc. normal saline solution by hypodermoclysis. In P.M. by lumbar puncture 5 cc. yellow fluid removed; cells 2,200; no increase in pressure; 20 cc. Parke

CASE IX (cont.)

Davis' serum intraspinally.

April 19: T.101.2; P.85 to 110; R.40. Given 1,000 cc. normal saline by hypodermoclysis. In A.M. by cisternal puncture 20 cc. yellow fluid removed; 10 cc. Lilly's concentrated serum intracisternally. In P.M. by lumbar puncture no fluid obtained. By cisternal puncture 25 cc. fluid removed; 15 cc. Lilly's concentrated serum intracisternally. Patient unable to void.

April 20: T.101; P.90; R.35. Urine: 1/2 albumen and 1/2 sugar. In P.M. by cisternal puncture 25 cc. slightly cloudy fluid removed; under less pressure; 15 cc. Parke Davis' serum intracisternally. Patient seems improved.

April 21: T.100; P.90 to 120; R.26. Frequent involuntary urinations. No spinal drainage or serum.

April 22: T.99 to 102; P.100; R.30. Rational. Involuntary urinations continue. Catheterized twice with large amount of residual each time. In P.M. by lumbar puncture 20 cc. fluid removed; pressure; 16 mm. Hg. rising to 24 on jugular compression; cells 2,500; 10 cc. Lilly's concentrated serum intraspinally.

April 23: T.100; P.90 to 110; R.24. Improved. In P.M. by cisternal puncture 20 cc. cloudy fluid removed; 15 cc. Parke Davis' serum intracisternally.

April 24: T.99; P.80 to 90; R.24. Quiet and improved. In A.M. by lumbar puncture 20 cc. cloudy

CASE IX (cont.)

fluid removed; 15 cc. Mulford's serum intraspinally.

April 25: T.98 to 100.5; P.80 to 90; R.24.

In A.M. by cisternal puncture 20 cc. fluid removed; cells 2,600; pressure 8 mm. Hg.; no organisms seen; culture negative; 10 cc. Lilly's concentrated serum intracisternally.

April 26: T.99; P.90; R.24. Blood count: hb. 80%; R.B.C. 4,230,000; W.B.C. 10,800.

April 27: T.98 to 99; P.90; R.24. Had projectile type vomiting. In P.M. by lumbar puncture 20 cc. slightly cloudy fluid removed; 15 cc. Parke Davis' serum intraspinally.

April 28: T.98 to 99; P.80 to 100; R.24. Must still be catheterized for residual urine. In A.M. by cisternal puncture 20 cc. cloudy fluid removed; pressure 12 mm. Hg.; cells 2,600; 10 cc. Lilly's concentrated serum intracisternally.

April 29: T.98 to 100; P.80 to 100; R.24. Quiet. In P.M. by lumbar puncture 15 cc. cloudy fluid removed; pressure 10 mm. Hg.; 10 cc. Lilly's concentrated serum intraspinally.

April 30: T.99; P.90 to 100; R.24. Urine: 3% sugar. Not taking fluids well; not eating so well. In P.M. by cisternal puncture 23 cc. fairly clear fluid removed; pressure 14 mm. Hg.; 15 cc. Parke Davis' serum intracisternally.

May 2: T.98 to 100; P.90 to 100; R.24. In P.M. by lumbar puncture 13 cc. slightly cloudy fluid removed; 13 cc. serum given intraspinally.

CASE IX (cont.) and CASE X

May 4: T.97 to 98.6; P.90 to 100; R.24.

Patient not taking fluids well. In P.M. by cisternal puncture 30 cc. cloudy fluid removed; pressure 22 mm. Hg.; 15 cc. Parke Davis' serum intracisternally.

May 5: T.100; P.90 to 100; R.20. In A.M.

by lumbar puncture 25 cc very cloudy fluid removed; pressure 22 mm. Hg. No serum given. In P.M. by lumbar puncture 15 cc. cloudy fluid removed; pressure 12 mm. Hg.; 10 cc. Lilly's concentrated serum intracisternally.

May 6: Patient died at 2:35 A.M.

AUTOPSY FINDINGS:

1. Suppurative basilar meningitis.
2. Cerebro-spinal fluid block.
3. Intracranial pressure.
4. Internal hydrocephalus.

CASE X: E. H., white female, married, age 23 years.

ADMITTED: April 24, 1931. HOSPITAL DAYS: 18.

ONSET AND DEVELOPMENT: On April 22, 1931 patient complained of nausea and malaise. On the 23rd went to bed with aching pains, none localized, and toward evening was restless. On the 24th became delirious and vomited once or twice.

FINDINGS ON ENTRANCE: Delirium; pupils fixed to light; neck rigidity; no Kernig; knee-jerks hyperactive. T.101.2; P.80; R.20. Blood count: 10,150 W.B.C. By lumbar puncture 35 cc. cloudy fluid removed; cells 18,500; intracellular Gram negative

CASE X (cont.)

diplococci on smear.

PROGRESS AND TREATMENT:

April 24: T.102; P.138; R.32. Given 15 cc. antimeningococcic serum intraspinally, and 30 cc. intravenously.

April 25: T.100.8; P.100 to 130; R. fell to 6 or 7 following morphine gr. $\frac{1}{4}$ and chloral hydrate gr.90; patient cyanotic; responded to adrenalin, atropin, and caffein. Blood count: Hb. 105%; R.B.C. 5,640,000; W.B.C. 14,900; polys 90%.

Urine: 3 plus albumen, many casts, and occasional R.B.C. per high power field. In A.M. by lumbar puncture 30 cc. cloudy fluid removed; pressure 18 mm. Hg.; smear showed a few organisms intracellular; culture negative. Given 15 cc. serum intraspinally and 30 cc. intravenously with normal saline solution. In P.M. by lumbar puncture 32 cc. cloudy fluid removed; no serum given; a small trochar was left in place as a permanent intraspinal drain. Patient given fluids by proctoclysis.

April 26: T.99 to 100.8; P.90 to 120; R.20. Given 2,000 cc. water by proctoclysis. Patient restless but responsive; complains of headache. Considerable drainage from trochar.

April 27: T.100 to 103; P. 100 to 110; R. 20 to 36. Spinal fluid drainage slightly bloody; cell count 1,000. Patient given 30 cc. serum intravenously.

CASE X(cont.) and CASE XI

April 28: T.100 to 101; P.100; R.20.
Patient improved, rational but slightly confused.
Urine: 3 plus albumen, many casts, few R.B.C.

April 29: T.99 to 100.8; P.100; R.20.
Patient brighter, no complaints. Spinal fluid
drainage clear, cells 140.

April 30: T.99 to 100.8; P.90 to 100; R.24.
Spinal fluid drainage clear. Trochar removed.

May 4: Patient has been running a low grade
fever around 100. An abscess is forming at site
of trochar drainage.

May 7: Abscess improved under magnesium
sulphate packs.

May 12: Patient dismissed. Wound at site of
spinal drainage not quite healed but improving
under silver nitrate stick. Temperature has been
normal since May 7th.

CASE XI: L. S., white, male, age 14 years.
ADMITTED TO LOCAL HOSPITAL: March 27, 1931.
ADMITTED TO UNIVERSITY HOSPITAL: April 25, 1931.
DAYS IN UNIVERSITY HOSPITAL: 13. DAYS ILLNESS: 44.
ONSET AND DEVELOPMENT: On March 26, 1931 patient
complained of headache. On the 27th vomited and
had convulsions, became stuporous, had head
retraction, and choked disc. Was taken to a
local hospital. lumbar puncture showed increased
spinal fluid pressure; cloudy fluid, and numerous

CASE XI (cont.)

intracellular diplococci on smear. Culture by State laboratory positive for meningococcus. 36 hours after onset was given Lilly's antimeningococcic serum intraspinally. 36 hours later was given 30 cc. Parke Davis' serum intraspinally. Subsequently was given intravenous injections of Mulford's and Parke Davis' serum. The first cell count was 23,000; the 2nd was 1,500. This gradually decreased until the last puncture (April 20th) 5 days before entrance into the University hospital was clear and under no pressure. During the 4 or 5 days previous to entrance into the university hospital the pulse tended to rise. Patient had involuntary urination for 2 weeks previous to entrance, and the mental state, previously clear, became characterized by delerium and hallucinations alternating with stupor. On April 24th patient had 4 convulsions and developed a suggestion of weakness of right side of face. Patient was transferred to University hospital with notation by his physician: "The response to intraspinal serum was quite marked for the first week; after that not much effect."

FINDINGS ON ENTRANCE: Semi-stuporous; opisthotonos; knee-jerks slightly exaggerated; Kernig positive. T.101; P.120; R.18; B.P.115/95.

PROGRESS AND TREATMENT:

April 26, 1931: T.100.4; P.100; R.20. Patient talkative; otherwise little change.

CASE XI (cont.)

April 27: T.102.4; P.120; R.24. By lumbar puncture 4 cc. clear fluid removed; cells 70; no increased pressure; no organisms on smear.

April 28: T.101; P.100 to 130; R.15 to 25. Blood count: R.B.C. 4,150,000; W.B.C. 13,200; polys 79%. By cisternal puncture 20 cc. slightly cloudy fluid removed; pressure 8 mm. Hg.; cells 1,500, polys 99%; very many intracellular meningococci seen on smear.

April 29: T.99.2 to 101.8; P.100 to 120; R.20 to 26. By cisternal puncture 25 cc. fairly clear fluid removed; 25 cc. Mulford's antimeningococcic serum intracisternally.

May 1: T.100; P.110; R.20. General condition improved. By cisternal puncture 25 cc. bloody fluid removed; pressure increased; 10 cc. Lilly's concentrated serum intracisternally.

May 5: T.99 to 100; P.80 to 134; R.20. Patient stuporous; pupils dilated; vomited; involuntary urination. By lumbar puncture only 2 drops of clear fluid obtained. By cisternal puncture 15 cc. almost clear fluid removed; pressure 9 mm. Hg.; 12 cc. Lilly's concentrated serum intracisternally.

May 6: T.99 to 100; P.80 to 140; R.16 to 38. Patient stuporous; given 500 cc. 10% glucose solution intravenously. In A.M. by cisternal puncture 25 cc. slightly cloudy fluid removed; pressure 3 mm. Hg.; cells 590, polys 98%; no organisms seen; 15 cc.

~~xxxxxx~~

CASE XI (cont.)

Lilly's concentrated serum intracisternally. In P.M. by cisternal puncture 15 cc. fluid removed; pressure 8 mm. Hg.; no serum given. Urine: 1 $\frac{1}{2}$ albumen.

May 7: T.100; P.120; to 132; R.24. Given 500 cc. 10% glucose solution intravenously. By cisternal puncture 18 cc. turbid fluid removed; pressure 7. mm. Hg.; 15 cc. Parke Davis' serum intracisternally. Bloody discharge from left ear; examination of ear revealed nothing on account of bleeding obscuring the view.

May 8: T.101.4; P.80 to 120; R.24 to 0. By cisternal puncture 15 cc. turbid and blood tinged fluid removed; many R.B.C., few W.B.C.; 12 cc. Parke Davis' serum intracisternally. Patient ~~xxx~~ stuporous, perspiring profusely, face flushed. At 8:10 P.M. patient became cyanotic and stopped breathing but heart beat continued. Given strychnine gr.1/30, and 50 cc. hypertonic glucose and alpha lobelin 2 cc. intravenously. Breathing recommenced; color improved. At 8:30 P.M. respirations ceased; heart ceased beating. Adrenalin 2 cc. intracardially of no avail. Patient died.

AUTOPSY FINDINGS:

1. Suppurative basilar meningitis.
2. Cerebro-spinal fluid block at base.
3. Internal hydrocephalus.
4. Intracranial pressure.
5. Left suppurative otitis media and mastoiditis (hemolytic streptococcus isolated.)

CASE XII

B. H., white, female, age 2 years.

ADMITTED: May 25, 1931. HOSPITAL DAYS: 92.

ONSET AND DEVELOPMENT: On May 22, 1931 patient developed sore throat and fever. On the 23rd was lethargic, and T.102. On the 24th developed neck rigidity and restlessness. On the 25th increased neck rigidity and positive Kernig and Brudzinski.

FINDINGS ON ENTRANCE: T.100.4; P.120; R.26.

Lethargic; bilateral positive Kernig and positive Brudzinski; head retraction; ~~xxx~~ no skin eruption.

PROGRESS AND TREATMENT:

May 25, 1931: By cisternal puncture 25 cc. cloudy fluid removed; cells 9,800; many Gram negative intracellular diplococci seen on smear; pressure 20 mm. hg.; 10 cc. Lilly's concentrated antimeningococcic serum intracisternally.

May 26: T.102.4. Blood count: hb. 90%; R.B.C. 4,800,000; W.B.C. 17,500; polys 68%. In A.M. by lumbar puncture 15 cc. turbid fluid removed and 10 cc. Lilly's concentrated serum intraspinally.

May 27: T.104. In A.M. by lumbar puncture 15 cc. fluid removed; 81% polys; few organisms seen; 15 cc. Mulford's serum intraspinally. In P.M. by lumbar puncture 30 cc. fluid removed and 10 cc. Lilly's concentrated serum intraspinally.

May 28: T.100.2 to 98. In A.M. by cisternal puncture 27 cc. quite clear fluid removed; 76%

~~polys; no organisms seen; 15 cc. Mulford's~~

CASE XII (cont.)

polys; no organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar puncture 30 cc. fluid removed. No serum given.

May 29: T.101.4. In A.M. by cisternal puncture 27 cc. slightly cloudy fluid removed; 20% polys; no organisms; no serum given. In P.M. by lumbar puncture 30 cc. reddish brown fluid removed. No serum given.

May 30: T.102. Blood count: W.B.C. 14,200, polys 68%. In A.M. by cisternal puncture 35 cc. slightly cloudy fluid removed; 84% polys; rare organisms seen intracellularly. In P.M. by cisternal puncture 35 cc. bright red fluid removed and 15 cc. Mulford's serum intracisternally.

May 31: T.104.6. In A.M. by cisternal puncture 50 cc. brownish fluid removed; no organisms seen; 15 cc. Clarke Davis' serum intracisternally. In P.M. by lumbar puncture 23 cc. xanthochromic fluid removed; no serum given.

June 1: T.104 to 105.8. In A.M. by cisternal puncture 30 cc. fluid removed; polys 88%; no organisms seen; 15 cc. Mulford's serum intracisternally. At 4 P.M. by lumbar puncture 40 cc. very cloudy fluid removed; 5 cc. Lilly's concentrated serum intraspinally. At 10:30 P.M. temperature reached 105.8 with P.148; patient distended and rigid.

CASE XII (cont.)

By cisternal puncture 30 cc. cloudy fluid removed and 15 cc. Mulford's serum intracisternally. Patient given 900 cc. normal saline solution by hypodermoclysis.

June 2: T.102 to 105.8. Blood count: W.B.C. 18,000, polys 78%. In A.M. by cisternal puncture 30 cc. very cloudy fluid removed; cells 2,520; polys 92%; a few organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by cisternal puncture 30 cc. cloudy fluid removed and 15 cc. serum intracisternally.

June 3: T.105.8 to 104. At 1 A.M. patient was stuporous, temperature 105.8, pulse irregular. Cisternal puncture was done removing 45 cc. fluid under high pressure; 15 cc. serum intracisternally. At 10 A.M. by cisternal puncture 40 cc. turbid fluid removed; polys 82%; no organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by cisternal puncture 20 cc. cloudy fluid removed; 10 cc. Lilly's concentrated serum intracisternally.

June 4: T.104. In A.M. by cisternal puncture 30 cc. yellow fluid removed; polys 94%; a few organisms seen; culture negative; 15 cc. Parke Davis' serum intracisternally. In P.M. by cisternal puncture 25 cc. cloudy fluid removed; 10 cc. Lilly's concentrated serum intracisternally.

June 5: T.103.6. In A.M. by cisternal puncture 25 cc. clear fluid removed; polys 97%; a few organisms seen; 15 cc. Mulford's

CASE XII (cont.)

few organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by cisternal puncture 30 cc. yellow fluid removed; 15 cc. Parke Davis' serum intracisternally.

June 6: T.103 to 98.6. Nasal feeding resorted to (and continued throughout hospital stay). In A.M. by cisternal puncture 30 cc. yellow fluid removed; cells 50; polys 60%; no organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by cisternal puncture 35 cc. clear fluid removed; 15 cc. Parke Davis' serum intracisternally.

June 7: T.99.6. In A.M. by cisternal puncture 53 cc. clear yellow fluid removed; polys 74%; no organisms seen; 15 cc. Parke Davis' serum intracisternally. In P.M. by cisternal puncture 42 cc. clear yellow fluid removed; 15 cc. Parke Davis' serum intracisternally.

June 8: T.97 to 101.6. In A.M. by cisternal puncture 45 cc. clear yellow fluid removed; polys 28%; no organisms seen; 10 cc. Lilly's concentrated serum intracisternally. Blood count: W.B.C. 9,100. In P.M. by lumbar puncture 32 cc. almost colorless fluid removed; 10 cc. Lilly's concentrated serum intraspinally.

June 24: T. has ranged between 99 and 101 till June 17th when it began to range around 103. Daily lumbar punctures have been made since the 17th draining between 40 and 80 cc. clear fluid

CASE XII (cont.)

each time; no organisms seen. Encephalogram done today, replacing 140 cc. clear fluid with an equal amount of air. Report: "Encephalogram shows marked internal hydrocephalus with obliteration of subarachnoid spaces anterior to the interpeduncular cistern."

July 1: T. approaching normal. Daily lumbar punctures have been made draining an average of 50 cc. fluid daily. Symptoms of hydrocephalus continue.

July 10: T. rose to 104. By lumbar puncture 20 cc. cloudy fluid removed; cells 2,750; pressure 21 mm. hg.; culture and smear positive for staphylococcus aureus. Patient put on supportive treatment and daily spinal drainage.

July 15: T. high and irregular. Spinal fluid clear today, but smear shows staphylococcus aureus (last positive report)

July 31: T. dropped to normal (remained normal till dismissed).

August 25: Frequent lumbar punctures have been done during the past month. Pressure now is reduced close to normal; fluid clear. Neurological and mental status unimproved. Patient dismissed to the County hospital.

CASE XIII

L. G., white, male, age 2 years.

ADMITTED: May 25, 1931. HOSPITAL DAYS: 21.

ONSET AND DEVELOPMENT: On May 23, 1931 patient became ill with vomiting, fever, and sore throat. No previous illness. (No further details of development were available.)

FINDINGS ON ENTRANCE: Lethargy; moderate neck rigidity and slight head retraction; headache; suggestive bilateral Kernig; macular skin eruption over the extremities. T. 102.6; P. 120; R. 28.

Urine: 2+ albumen, 2+ acetone, 2+ diacetic acid, and occasional W.B.C. per high power field. Blood count: Hb. 88%; R.B.C. 4,830,000; W.B.C. 34,000; polys 80%.

PROGRESS AND TREATMENT:

May 26: T. 101; P. 120; R. 22. By lumbar puncture 18 cc. turbid fluid removed; pressure 30 mm. Hg.; cells 900 (?); Gram negative intracellular diplococci seen in smear; 10 cc. Lilly's concentrated antimeningococcic serum given intraspinally.

May 27: T. 102 to 103.4; Blood count: W.B.C. 13,150; polys 46%, eosins 14%. In A.M. by cisternal puncture 50 cc. fluid removed; polys 95%; no organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar puncture 30 cc. fluid removed; 10 cc. Lilly's concentrated serum intraspinally.

CASE XIII (cont.)

May 28: T.102 to 98.6. Patient clinically improved. In A.M. by cisternal puncture 37 cc. slightly cloudy fluid removed; pressure less; 84% polys; no organisms seen; 15 cc. Mulford's serum intracisternally. In P.M. by lumbar puncture 26 cc. fluid removed; no serum given.

May 29: T.98.6 to 101.6. In A.M. by cisternal puncture 25 cc. slightly cloudy fluid removed; cells fewer; polys 85%; no organisms seen; no serum given. In P.M. by lumbar puncture 18 cc. fairly clear fluid removed; no serum given.

May 30: T.98.6 to 99.6. In A.M. by cisternal puncture 45 cc. fairly clear fluid removed; polys 73%; no organisms seen. In P.M. by lumbar puncture 8 cc. slightly colored fluid removed; no serum given.

May 31: (T.F.R. flat from here on for rest of hospital stay.) In A.M. by cisternal puncture 20 cc. clear fluid removed; polys 71%; no organisms seen. In P.M. by lumbar puncture 38 cc. yellow fluid removed. No serum given.

June 1: In A.M. by cisternal puncture 20 cc. fluid removed; polys 90%; no organisms seen. In P.M. by lumbar puncture 15 cc. clear fluid removed.

June 2: By cisternal puncture 10 cc. clear fluid removed; cells 40; 64% polys; no organisms seen.

June 3: By cisternal puncture 10 cc. clear fluid removed; polys 21%; no organisms seen.

June 4: Nose and throat cultures positive for

CASE XIII (cont.) and CASE XIV

meningococci.

June 6: By lumbar puncture 30 cc. clear fluid removed; no pus cells; no organisms seen.

June 9: Nose culture positive for meningococcus. Throat culture negative for meningococcus.

June 13: Nose and throat cultures positive for meningococcus.

June 14: Patient dismissed. Condition good.

CASE XIV

D.S., white, female, age 8 years.

ADMITTED: September 8, 1931. HOSPITAL DAYS: 11.

ONSET AND DEVELOPMENT: Patient had been ill for 2 weeks previous to entrance with vomiting and anorexia. On Sept. 8 became listless, crying, and had stiffness of neck, head retraction, and vomiting.

FINDINGS ON ENTRANCE: Neck and back rigidity; head retracted; cries out in sleep; cries when neck is flexed; no bulging of anterior fontanelle; reflexes hyperactive; Kernig negative; T. 102.6.

PROGRESS AND TREATMENT:

Sept. 9: T. 101.4. Macular eruption over back. Marked strabismus at times. Lumbar and cisternal punctures attempted, but no fluid obtained. Started on aspirin gr. 1 q. hour.

Sept. 10: T. 101. Vomited once. Condition unchanged.

Sept. 11: T. 101.2. Vomited repeatedly.

Sept. 12: T. 101.8 to 98.6. Developed involuntary jerkings. Vomited repeatedly. Perspiring pro-

CASE XIV (cont.) and CASE XV

fusely.

Sept.13: T.102.2. Lumbar puncture attempted; no fluid obtained. No change in condition.

Sept.14: T.101.2. Cisternal puncture attempted; no fluid obtained. By ventricular puncture 15 cc. thick cloudy fluid removed; cells 1,280; smear showed meningococci; culture negative for meningococcus. Given 10 cc. Lilly's concentrated antimeningococcic serum intraventricularly.

Sept.15: T.101.8. No change in general condition. By ventricular puncture 15 cc. purulent fluid removed; 10 cc. Parke Davis' serum intraventricularly.

Sept.16: T.102.4. Blood count: hb. 90%; R.B.C. 4,540,000; W.B.C. 15,300; polys 73%. By ventricular puncture 15 cc. pale straw-colored fluid removed; 10 cc. Lilly's concentrated serum intraventricularly.

Sept.17: T.101.8. By ventricular puncture 15 cc. yellow cloudy fluid removed; 10 cc. Parke Davis' serum intraventricularly.

Sept.18: T.101.6. At 10:30 A.M. patient became cyanotic and respirations and heart beat ceased. No autopsy secured.

CASE XV

D.G., white, female, age 14 years.

ADMITTED: Nov.21,1931 at 11:45 P.M. HOSPITAL DAYS: 21.

ONSET AND DEVELOPMENT: On Nov.19 patient awoke at

CASE XV (cont.)

4 A.M. crying, had a chill, nausea and vomiting, and headache. T. reached 106. Deafness developed in P.M. On Nov. 20th a blotchy skin eruption appeared over the body.

FINDINGS ON ENTRANCE: Prostration; head retraction and pain on flexion of neck; macular skin eruption disappearing on pressure; throat congested; eyes react sluggishly to light and accommodation; pulse thready; Kernig not demonstrable. T. 103.4; P. 110; R. 24; W.B.C. 28,800.

PROGRESS AND TREATMENT:

Nov. 22: T. 104; P. 90 to 100. At 1 A.M. by lumbar puncture 30 cc. cloudy fluid removed; cells 490(?); no organisms seen on smear; 20 cc. Lederle's anti-meningococcic serum intraspinally and 10 cc. intravenously. At 10:30 A.M. by lumbar puncture 30 cc. cloudy yellow fluid removed; 20 cc. Lederle's serum intraspinally and 10 cc. intravenously. Blood culture negative for meningococcus. At 8 P.M. by cisternal puncture 30 cc. cloudy fluid removed; 22 cc. Parke Davis' serum intracisternally and 8 cc. intramuscularly.

Nov. 23: T. 103; P. 90 to 110. In A.M. by lumbar puncture 30 cc. turbid fluid removed; cells 9,400; intracellular Gram negative diplococci seen on smear; 20 cc. Parke Davis' serum intraspinally and 10 cc. intravenously. In P.M. by lumbar puncture 30 cc. cloudy fluid removed; cells 11,200; no organisms

CASE XV (cont.)

seen; 10 cc. Lilly's concentrated serum intraspinally.

Nov.24: T.102.8; P.90 to 120. In A.M.: by lumbar puncture 30 cc. turbid fluid removed; cells 10,400; no organisms seen; no serum given. Patient given 100 cc 50% glucose solution intravenously. In P.M. by lumbar puncture 20 cc. cloudy fluid removed; cells 8,600; no organisms seen; 10 cc. Lilly's concentrated serum intraspinally.

Nov.25: T.98.6 to 102.8; P.80 to 100. In A.M. by lumbar puncture 45 cc. cloudy fluid removed; cells 6,400; no organisms seen; no serum given. In P.M. by lumbar puncture 60 cc. cloudy fluid removed; cells 4,700; no organisms seen; no serum given. Notation by Dr.J.J.Keegan: "Patient definitely improved. No complaint this evening of headache. Neck only moderately stiff. Can turn over in bed. No meningococci in fluid for several days. Recommend complete spinal drainage every 12 hours until cell count under 500. No more serum unless cell count rises or meningococci found. See no advantage in cisternal drainage as long as free spinal flow is obtained."

Nov.26: T.99.6 to 102.8; P.80 to 150. Developed articular eruption with itching, restlessness, discomfort, and rise in temperature. In A.M. by lumbar puncture 70 cc. cloudy fluid removed; cells 3,800; no organisms seen; 30 cc. Parke Davis' serum intraspinally. In P.M. by lumbar puncture 65 cc. cloudy fluid removed; cells 4,100; no organisms seen; no

CASE XV (cont.)

serum given.

Nov. 27: T. 100 to 103.6; P. 110 to 140.

Urine: 2+ albumen. Blood count: Hb. 78%; R.B.C. 3,900,000; W.B.C. 18,400; polys 87%. In A.M. by lumbar puncture 50 cc. cloudy fluid removed; no organisms seen. In P.M. by lumbar puncture 50 cc. cloudy fluid removed; cells 4,900; no organisms seen.

Nov. 28: T. 100 to 102; P. 90 to 120. In A.M. by lumbar puncture 40 cc. slightly cloudy fluid removed; cells 1,000; no organisms seen. In P.M. by lumbar puncture 45 cc. slightly cloudy fluid removed; cells 860; no organisms seen.

Nov. 29: T. 100 to 102; P. 90 to 140. In A.M. by lumbar puncture 40 cc. clear fluid removed; cells 400; no organisms seen. Notation by Dr. J.J. Keegan: "Patient has had considerable serum reaction, beginning 11-25-31, with coincident rise in temperature, discomfort, restlessness, itching, and urticarial ~~eruption~~ eruption. This is subsiding today. Would suspect delayed improvement due largely to serum reaction rather than to infection."

Nov. 30: T. 99; P. 90. By lumbar puncture 30 cc. clear fluid removed; cells 100.

Dec. 1: (T.P.R. normal throughout rest of hospital stay.)

Dec. 7: Urinalysis negative. Patient gaining strength steadily. Still totally deaf. Nose and

CASE XV (cont.)

throat cultures positive for meningococcus.

Dec.12: Nose and throat cultures still positive for meningococci, but avirulent strains (?).

Residual complete bilateral deafness. Patient dismissed.
