

EPIDEMIC CEREBROSPINAL MENINGITIS AS
OBSERVED AT GENERAL HOSPITAL
NO. 6, FORT McPHERSON, GA.,
WINTER OF 1917 AND 1918*

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This report includes cases of epidemic cerebrospinal meningitis at General Hospital No. 6, Fort McPherson, Georgia, from Oct. 1, 1917, to May 1, 1918, a period of seven months. Ten patients were treated and the diagnosis was confirmed in every case by the presence of the meningococcus in the spinal fluid.

Methods Employed in Care of Meningitis Cases.—Meningitis patients were isolated in single rooms. Clothing, bed clothes, dishes, bedpans and urinals were sterilized. Throat cultures were taken from convalescent patients every four days until three negative cultures were obtained, and from physicians, nurses and attendants, every four days during their contact with patients. If a positive culture was obtained in a patient he was treated with a spray of dichloramin-T in chlorcosane. Physicians, nurses and attendants received this spray routinely every four hours.

Prophylactic Measures.—The following prophylactic measures were employed immediately on the diagnosis of meningitis being made: All contacts were isolated until negative throat cultures were reported. Any person having a positive culture was immediately isolated until three negative cultures, four days apart, were obtained. The throat was sprayed several times a day with dichloramin-T in chlorcosane. For the six hours preceding a throat culture the spray was not used.

Case 5 of this series illustrates the way in which contacts were followed up. The patient belonged to a hospital unit stationed at Fort McPherson. The entire unit of twelve officers and fifty men were immediately quarantined in their barracks and throat cultures taken. One officer, having left in the interval, was located and ordered to report to the department laboratory of the city in which he was;

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a telegraphic report being sent by the department pathologist. One carrier was found in this unit, and immediately isolated until three negative cultures were obtained.

Physicians, nurses and attendants wore caps, gowns and masks when entering the patient's room. Physicians and nurses were not isolated when off duty, but attendants, who were not sufficiently trained in taking proper precautions, were isolated.

Our method of dealing with cases on reception at the hospital will be considered later.

Because of the marked variations of severity, symptoms and course presented by our cases, a brief description of each case is necessary before drawing our conclusions.

REPORT OF CASES

CASE 1.—The patient came by ambulance from Atlanta. He said that less than twenty-four hours before admission he had had a chill, with nausea, vomiting and headache and a temperature of 104 F. On admission he complained of pain in the chest, cough and fever; the cheeks were flushed. He was admitted as a case of lobar pneumonia.

Examination of the lungs was negative. Blood examination, next day: red blood corpuscles, 4,556,000; white blood corpuscles, 7,000; hemoglobin, 90 per cent.; differential: polymorphonuclears, 82 per cent.; for malaria, negative. His temperature, which was 104.6 on admission (pulse 100, respiration 28), in a few hours dropped to subnormal and remained there for four days. On the fifth day it went to 102.2; white blood cells, 23,800; 90 per cent. polynuclears. The next day, white blood cells 29,800. On the sixth day (November 30) he showed slight stiffness of the neck and a faintly positive Kernig. Lumbar puncture was done; spinal fluid appeared perfectly clear; unfortunately the tube was broken in transmission to the laboratory. Another lumbar puncture was made the next day (December 1); fluid cloudy; 20 c.c. of antimeningococcus serum were administered at once. The laboratory report showed "globulin, double plus; cell count 7,500; smear, very few gram-negative diplococci, some of which were intracellular; culture, hay bacillus (contamination)." From this time on the patient had fever, either intermittent or remittent. At times there was slight delirium. He complained a great deal of headache and morphin was necessary to control it. He was given in all, eleven intraspinal treatments; total, 232 c.c. of serum.

December 10, patient much better; temperature normal. December 11, temperature 102.6; he complained of severe headache and urticaria. In spite of the probability of this being due to the serum, we felt that the continued administration of serum was indicated. Serum was therefore given for the next two days and then discontinued as temperature returned to normal inside of twenty-four hours and the headache likewise disappeared. The urticaria persisted for about three or four days. The patient then made an uneventful recovery and after a month's leave of absence was returned to duty, Jan. 30, 1918.

CASE 2.—The patient complained of general pains all over the body, especially in neck and back. Temperature 101; pulse 110; respirations 26. On examination, his neck was somewhat rigid and attempts to elicit the Kernig sign produced slight pain in the back.

Lumbar puncture: fluid cloudy with decreased pressure, and when 12 c.c. were removed the patient complained of such excruciating headache that withdrawal of spinal fluid was stopped and 17 c.c. of serum administered. The introduction of the serum immediately stopped the headache.

REPORT ON SPINAL FLUID

Date	Globulin	Cell Count	Smear	Culture
12/1	++	7,500	Polys., 87%; lymphs., 13%; very few gram-neg. intracellular diplococci	Hay bacillus (contaminated)
12/2	+	Colloidal gold 0-0-1-2-3-1-0-0-0
12/3	++	930	Polys., 65%; monos., 35%; occasional gram-neg. diplococci (intracellular)	Negative
12/4	Cells disintegrated; no micro-organisms found	B. subtilis
12/5	Wassermann anticomplementary
12/6	Colloidal gold 0-0-1-2-3-2-5-2-1
12/7	++	4,000	Polys., 86%; monos., 14%; numerous gram-neg. intracellular diplococci	Gram-neg. diplococci; no agglutination with polyvalent serum (antimeningitis)
12/8	1,400	.....	Negative
12/9	++	5,700	Polys., 86%; monos., 14%; no micro-organisms	Negative
12/10	++	3,100	Polys., 74%; lymph., 26%	
12/11	+++	760	Polys., 82%; monos., 18%; no micro-organisms	
12/12	+	480	Polys., 18%; monos., 82%; no bacteria	Negative; colloidal gold, 5-5-5-3-2-2-2-1-1-1

REPORT ON INTRASPINOUS INJECTION OF SERUM

Date	Serum Given Intraspino- usly, C.c.	Fluid Withdrawn, C.c.	Date	Serum Given Intra- spino- usly, C.c.	Fluid Withdrawn, C.c.
12/1/17	22	25	12/ 7/17	20	30
12/2/17	30	30	12/ 8/17	20	30
12/3/17	20	30	12/ 9/17	20	30
12/4/17	20	30	12/10/17	20	30
12/5/17	20	30	12/11/17	30	30
12/6/17	20	30	Total	232	325

The patient was given six intraspinoous injections, a total of 115 c.c. At no time was the patient in bad condition or suffering severely. He made an uneventful recovery.

On the eighth day, herpes labialis appeared. On the thirteenth day, serum sickness occurred, with urticaria, but no rise in temperature.

CASE 3.—The patient (Pvt.) was admitted Dec. 15, 1917, with "German measles." December 22 apparently well. December 23, was taken with vomiting and headache, and soon became delirious; opisthotonos present and Kernig positive; lumbar puncture: fluid cloudy; 18 c.c. of antimeningococcus serum administered; nine doses of serum, once daily; total 168 c.c. administered. The patient made an uneventful recovery. On the third day a profuse herpes labialis appeared. Serum sickness occurred December 29, the seventh day,

a fine punctiform, erythematous rash appearing on the face, chest and back, which itched slightly; no headache, pains in joints, or fever. The fever was remittent and irregular, but not intermittent.

CASE 4.—The patient (Pvt.) was admitted at 6:30 a. m., Feb. 16, 1918, delirious and struggling. Three men were required to hold him; delirium so profound that he could not be aroused. The only history which could be obtained was that he had been taken with a violet headache at 2 a. m. the same day, and rapidly grew delirious. Temperature was 104, pulse 88, respirations 24. Physical examination was negative. There was no neck rigidity. Kernig was negative. Lumbar puncture was done at 9 a. m.; fluid cloudy; under some pressure; 20 c.c. of antimeningococcus serum administered. Patient grew weaker, and at 1 p. m. died suddenly. The spinal fluid showed globulin quadruple plus; cell count 8,000; smear 95 per cent. polys., monos., 5 per cent.; cells studded with gram-negative diplococci; culture showed meningococcus of intermediate Type 10. Necropsy showed characteristic lesions of the disease.

REPORT ON SPINAL FLUID

Date	Globulin	Cell Count	Smear	Culture
1/10	++++	8,000 (estimated)	Many very large gram-negative intracellular diplococci	Meningococcus; agglutination; para type
1/11	++++	15,900	Polys., 89%; monos., 11%; no meningococci seen	No growth
1/12	++	5,900	Polys., 95%; monos., 5%.....	Negative
1/13	++	980	No micro-organisms seen.....	Negative
1/14	++	520		
1/15	++	300	Polys., 40%; monos., 60%; no bacteria	Negative

REPORT ON INTRASPINOUS INJECTION OF ANTIMENINGOCOCCIC SERUM

Date	Serum Given Intraspino- sly, C.c.	Fluid Withdrawn, C.c.	Date	Serum Given Intra- spino- sly, C.c.	Fluid Withdrawn, C.c.
1/10	17	12	1/14	20	25
1/11	20	20	1/15	20	20
1/12	18	25			
1/13	18	25	Total	113	127

CASE 5.—Patient admitted Jan. 25, 1918; diagnosis, "suspected meningitis." On admission he was delirious; temperature 104. During the afternoon he complained of pains all over the body, especially back of head and neck. He worked until 6 p. m., and at 9 p. m. was in delirious condition; orthotonos, but no opisthotonos; Kernig negative. Lumbar puncture: fluid cloudy; 20 c.c. antimeningococcus serum was administered; treatment continued for three days; delirium disappeared, and the patient became quiet and rational. Temperature ranged from 98.6 to 100, and it was thought that he was beginning to convalesce. The next day his temperature rose, he became delirious and there was marked opisthotonos. One intraspino- treatment was given daily for four days, during which time the patient grew steadily worse. His temperature increased and delirium became profound. He was so restless that it was found necessary to alternate morphin, $\frac{1}{4}$ grain, and chloral, 10 grains,

sodium bromid, 20 grains, every two hours. Intraspinous treatments were increased to two a day. On the eleventh day of the disease an intravenous treatment of 50 c.c. of serum was given. The immediate effect was a rise in temperature. Six days later a second intravenous treatment was given, and four more the next four days. During all this time the two intraspinal treatments were given daily. The patient would always have a chill within an hour after treatment, with a rise of temperature to about 104. During this time he gradually grew better. The patient received treatments every day for twenty-two days; thirty-three intravenous treatments were given, a total of 675 c.c. of serum, and six intravenous injections, a total of 295 c.c., or a grand total of 970 c.c. of serum. Serum sickness occurred the tenth day after treatment was stopped, and the thirty-second day of the disease. The temperature had been normal for eight days. Serum sickness manifested itself by severe pains in the knees, most pronounced in the left knee, and by a temperature of 104.4.

REPORT ON SPINAL FLUID

Date	Globulin	Cell Count	Smear	Culture
12/23	++++	Disintegrated	Few gram-neg. biscuit-shaped diplococci; some intracellular	No growth
12/24	5,900	Polys., 92%; monos., 8%	
12/25	8,000		
12/26	++	1,700	Polys., 72%; monos., 28%; occasional gram-neg. extracellular diplococci	No growth
12/27	+	750	Polys., 55%; monos., 45%; no bacteria seen	No growth
12/28	+	60	Few disintegrated cells; no organisms.....	No growth
12/29	+	30	.....	No growth
12/31	+	260	.....	Streptococcus, gram-neg.

REPORT ON INTRASPINOUS INJECTION OF SERUM

Date	Serum Given Intraspinously, C.c.	Fluid Withdrawn, C.c.	Date	Serum Given Intraspinously, C.c.	Fluid Withdrawn, C.c.
12/23	18	20	12/28	20	25
12/24	18	23	12/29	20	25
12/25	20	25	12/30	20	25
12/26	17	10	12/31	15	10
12/27	20	25			

Convalescence was very protracted and the patient is still (November 1) in the hospital, but is able to be up and around, though there is back and leg weakness. This postmeningitis asthenia, with spasticity of the legs, has been a feature lasting many weeks after the acute stage and deserves a special study and report.

CASE 6.—Patient (Pvt.) admitted Feb. 21, 1918, in a profound delirium of very acute onset; that is, less than twenty-four hours, and concerning which no history was obtainable. On admission he could not be aroused, struggled constantly, and had to be restrained. Temperature 100.2, pulse 54, respirations 20. Physical examination was negative; no neck rigidity and no Kernig;

lumbar puncture, fluid cloudy; 20 c.c. of serum administered; 20 c.c. intraspinously again administered within six hours of first dose; and 60 c.c. intravenously and two intraspinal treatments for next two days. His delirium had almost cleared up by this time and he was much improved. After one more intravenous and one more intraspinal treatment, the treatments were discontinued, although his temperature was above 102 for two days after the serum was discontinued. The patient made an uneventful recovery. Kidneys showed red blood corpuscles and hyaline, granular and blood casts. He had to be catheterized. On the ninth day, an erythematous rash appeared all over the body, followed by urticaria. There was no fever, headache or pain in joints.

CASE 7.—Patient (Pvt.) stepped on nail Feb. 14, 1918, making a superficial puncture on dorsum of left foot. Wound dressed and 15,000 antitetanic serum administered. He was kept in the post hospital. Three days later he had convulsions. Further history not obtainable. Thirty days later he was transferred to General Hospital No. 6, March 16, 1918, with a diagnosis of "(1) concussion of the brain or probable fracture of the skull, accidental; (2) meningitis traumatic; (3) pneumonia, lobar, left upper." The diagnosis on admission was "insanity, following traumatism, acute." History obtained from paternal uncle: "Father is a drunkard; one maternal aunt had epilepsy; three brothers and one sister are nervous, and patient was always considered feeble-minded."

Physical examination on admission showed that the patient was very weak and emaciated; beginning bed sore on right side; eyes protruding, movements free, pupils irregular, oval in outline, central and react sluggishly to light; some increase of intra-ocular tension; tongue dry and coated; knee jerks and ankle jerks markedly exaggerated; no Kernig; no Babinski; abdominal, cremasteric, biceps and triceps reflexes normal; heart, lungs, and abdomen negative. Mental examination: in bed; semiconfused; answers only after questions are repeated several times. Answers are fairly coherent; at times he is very noisy; speech is rambling, and he has acute hallucinations; he wets and soils himself; lumbar puncture two days after admission; laboratory report on spinal fluid as follows: Wassermann, weakly positive at 0.5 c.c.; globulin double plus; cell count 180; colloidal gold 0-0-0-0-0-0-0-0-0-0-. Roentgenogram of heart, lungs and gallbladder negative. Urine showed a trace of albumin and many casts. Red blood cells, 4,800,000; white blood cells, 13,400; blood culture sterile.

The patient was also examined by the chiefs of the medical and surgical services and the head of the eye service. The eyegrounds were reported negative. The case was regarded as syphilitic meningitis or brain tumor. The patient's temperature was normal.

While in the hospital the patient gradually grew weaker and became greatly emaciated. Persistent vomiting soon developed and followed the taking of food. The temperature remained normal.

Examination April 18, 1918, thirty-three days after admission revealed the following: heart sounds very weak; pulse 116; left patellar reflex normal; right slightly decreased; neck not as flexible as one would expect from a semicomatose patient, though not markedly rigid; well-marked *taché*. Lungs negative. The possibility of a tuberculous meningitis was also considered, and it was planned to examine the spinal fluid for tubercle bacilli, but before this was done the patient died, after being under our care thirty-seven days and in the post hospital before coming here thirty days.

Necropsy showed the ventricles of the brain greatly distended with a semipurulent fluid in which the meningococcus was present. (Internal hydrocephalus, bilateral); meningitis (meningococcus.) The spinal canal was

REPORT ON SPINAL FLUID

Date	Cell Count	Globulin	Smear	Culture
1/25	5,000	++++	Many pus cells; gram-neg. intracellular diplococci	Gram-pos. bacillus; probably contam.
1/26	6,000	.....	Few atypical gram-neg. diplococci	
1/27	1,800	.....	Polys., 90%; monos., 10%; no organisms seen	Negative
1/28	2,100	.....	No bacteria	
1/29				
1/30	700	+ ●	No organisms found.....	Negative
1/31	3,800	++	Few extracellular gram-neg. diplococci...	Negative
2/ 1	1,800	++	No organisms seen.....	Negative
2/ 2	1,100	+	Polys., 70%; monos., 30%; no organisms seen	Negative
2/ 5	820	+	No organisms seen.....	Negative
2/ 6	280	● +	No organisms seen.....	Negative
2/ 6	over 1,000	.....	No organisms seen	
2/ 7	330	+	Polys., 85%; monos., 15%; no organisms	Negative
2/ 8	170	+++	Many gram-neg. cocci resembling meningococci	Negative
2/ 9	1,560	++	No organisms found.....	Staphylococcus albus (Strepto.)
2/10	1,600	++++	No organisms found.....	B. subtilis
2/12	720	+++	No organisms seen.....	B. subtilis
2/14	70	++++	Cells disintegrated; no organisms seen....	Negative

Blood culture, Feb. 11, 1918, sterile.
 Blood count, Feb. 15, 1918, red blood cells, 4,270,000; white blood cells, 1,700; polymorphonuclears, 86 per cent.; mononuclears, 14 per cent.

REPORT ON INTRASPINOUS AND INTRAVENOUS INJECTION OF SERUM

Date	Serum Given Intraspino-ously, C.c.	Fluid With-drawn, C.c.	Serum Given Intraven-ously, C.c.	Date	Serum Given Intraspino-ously, C.c.	Fluid With-drawn, C.c.	Serum Given Intraven-ously, C.c.
1/25	20	17		2/ 8	20	50	
1/26	20	30		2/ 8	20	60	
1/27	20	25		2/ 9	20	55	
1/28	20	10		2/ 9	20	60	
1/29	20	8		2/10	20	46	
1/30	20	25		2/10	20	45	40
1/31	20	40		2/11	30	60	
2/ 1	20	38		2/11	25	50	50
2/ 2	20	60		2/12	20	60	
2/ 3	20	45		2/12	20	60	50
2/ 3	20	60		2/13	20	60	
2/ 4	20	45		2/13	20	60	45
2/ 4	20	67	50	2/14	20	40	
2/ 5	20	60		2/14	20	60	60
2/ 6	20	70		2/15	20	60	
2/ 6	20	70			675 295	1,706	295
2/ 7	20	70		Total serum given.....	970		
2/ 7	20	70					

occluded so that the meningeal fluid did not freely enter the spinal canal. Puncture of the cisterna magnum should have been done had the possibility of this occlusion occurred to us.

REPORT ON SPINAL FLUID

Date	Globulin	Cell Count	Smear	Culture
2/21	R. B. C. pus, and some gram-neg. bacilli; no meningococci observed	
2/22	++++	39,000	Many pus cells; gram-neg. intracellular diplococci	Meningococcus — normal agglutinates: 1:400 with normal antiserum; 1:100 with intermediate antiserum; no agglutination with para antiserum; 1:200 with polyvalent antiserum

REPORT ON INTRASPINOUS AND INTRAVENOUS ADMINISTRATION OF SERUM

Date	Serum Given Intraspinously, C.c.	Fluid Withdrawn, C.c.	Serum Given Intravenously, C.c.
2/21	20 25	30 40	60
2/22	20 20	50 15	
2/23	20 20	35 12	
2/24	20	3	55
Total	145	185	115

CASE 8.—Patient was admitted April 18, 1918, from war prison barracks, with a diagnosis of suspected spinal meningitis. He was semidelirious; complained of severe headache, pain in neck and back and vomiting. There was marked opisthotonos. The temperature was 97.6 F., pulse 76, respirations 20. Lumbar puncture clear, under normal pressure. The clinical signs being so marked, 20 c.c. of antimeningococcus serum were given. Laboratory report: spinal fluid, globulin negative; cell count 50; smear negative; culture meningococcus.

The patient was given two intraspinal treatments daily for three days, and then one daily for four days. It was necessary to chloroform him for all of his treatment as he struggled so violently.

At the end of this time it was felt that he was not making satisfactory progress. There was a profound delirium, weak, irregular pulse, and stimulation was necessary for the heart. The temperature was 103.8 and the patient complained incessantly of excruciating pains in the head. The next day the patient was given two intraspinal treatments and one intravenous treatment of 50 c.c. He had a chill and temperature rose to 104.8 and urticaria appeared. The next morning the temperature was normal and remained practically normal all day. All serum treatment was discontinued and patient made an uneventful recovery, the temperature never being more than 1 degree above normal.

REPORT ON SPINAL FLUID

Date	Globulin	Cell Count	Smear	Culture
4/19	Neg.	50	Negative.....	Meningococcus
4/19	++	2,850	Pus and some partially autolyzed organism, probably meningococci	
4/20	++	1,725	Some pus cells; no organisms.....	Negative
4/21	++	2,200	Not done.....	Not done
4/22	++	1,300	Not done.....	Not done
4/22	+++	500	Not done.....	Not done
4/25	++	3,400	Not done	

April 27: White blood cells, 11,100; polymorphonuclears, 82 per cent.; mononuclears, 18 per cent.

REPORT ON INTRASPINOUS AND INTRAVENOUS ADMINISTRATION OF SERUM

Date	Serum Given Intraspino- sly, C.c.	Fluid Withdrawn, C.c.	Serum Given Intravenously, C.c.
4/19	20	30	
4/19	20	30	
4/20	20	30	
4/20	20	20	
4/21	20	50	
4/21	20	50	
4/22	30	30	
4/23	..	50	
4/24	20	40	
4/25	24	60	
4/26	30	40	
4/26	30	40	
4/26	..	..	50
Total	274	470	50

Blood count April 27, 1918: white blood cells 11,000, polymorphonuclears 82 per cent., mononuclears 18 per cent. June 28, 1918, this patient had recurrence of meningitis which ran a course similar to the initial attack and from which he recovered.

CASE 9.—The patient (Pvt. J.), who was admitted from Camp Gordon with a diagnosis of "fever, type undetermined," said that while on a hike two days before his left arm and side began to feel numb, with pain in shoulders and back of neck. On admission he seemed in fairly good condition; complained of pain in back and soreness in the back of neck. There was also a "catchy" pain over the heart at times. Physical examination showed a few râles at base of left lung, with bronchial breathing over left upper lobe.

There was slight tenderness over left side of abdomen. The temperature was 100.4, pulse 80, respirations 20. First diagnosis, "influenza."

April 20, 1918, thirteen days later, the temperature was 104, pulse 104, respirations 28, with nausea, vomiting, rigidity and tenderness over right side of abdomen. He was seen by the surgical service as a possible case of appendicitis. Blood showed white blood corpuscles 32,800. Examination for malaria was negative. Headache developed, with pain and stiffness of neck and slight Kernig.

April 22, the temperature was 102.8, pulse 86, respirations 28. Lumbar puncture under chloroform secured a cloudy fluid. Twenty c.c. of antimeningococcus serum were given. The next day two intraspinal treatments were given, and then one daily for three days. Four days after the last serum and eight days after first serum was given, the patient broke out with urticaria. He made an uneventful recovery.

REPORT ON SPINAL FLUID

Date	Globulin	Cell Count	Smear	Culture
4/22	++	6,100	Pus and a few extracellular gram-negative diplococci	Negative
4/23	++	2,700	Not done.....	Not done

REPORT ON INTRASPINAL INJECTION OF SERUM

Date	Serum Given Intraspinaly, C.c.	Fluid Withdrawn, C.c.	Date	Serum Given Intraspinaly, C.c.	Fluid Withdrawn, C.c.
4/22	20	50	4/25	20	40
4/23	20	60	4/26	30	40
4/23	20	50			
4/24	20	25	Total	130	265

CASE 10.—The patient (Pvt.) who was admitted April 9, 1918, with a diagnosis of "influenza," for two days prior to admission complained of fever, headache and pain across the abdomen, extending to back; similar complaint on admission. Physical examination was negative, except for a slight pharyngitis. Temperature on admission, 102.2; normal in four days, when patient appeared to be convalescing. April 22, thirteen days after admission, he had a chill after supper. The temperature rose to 104, pulse 86, respirations 20. His temperature next morning was 100.6. He complained of headache, pain in back of neck and generalized pain in abdomen. Opisthotonos was present and Kernig faintly positive, yet his answers were so contradictory, and he was so frightened when examined that one felt doubtful about the signs. Lumbar puncture fluid was purulent. The laboratory report showed pus cells and thousands of meningococci. Twenty c.c. of antimeningococcus serum were administered. At this time the temperature was 104, pulse 160, and respirations 36, the two latter probably due to fright. The next day the temperature was subnormal all day. One intravenous treatment of 50 c.c. was given, and intraspinal treatments, one of 20 c.c., and some of 40 c.c. Two intraspinal treatments were given daily for two days more. The temperature gradually increased up to 101. Treatment was then omitted for three

days, when one intraspinal injection of 15 c.c. was given. April 30, the patient had a chill, with rise of temperature to 103.6, but during the next three days it returned to normal, and the patient made an uneventful recovery.

April 28, he complained of pain in the left ankle; May 1, pain in both ankles; May 2, orchitis, left. There was no rash or rise of temperature.

REPORT ON SPINAL FLUID

Date	Globulin	Cell Count	Smear	Culture
4/23	++	400	Pus and thousands of meningococci	Meningococcus

REPORT ON INTRASPINAL AND INTRAVENOUS ADMINISTRATION OF SERUM

Date	Serum Given Intraspinaly, C.c.	Fluid Withdrawn, C.c.	Serum Given Intravenously, C.c.
4/23	20	40	
4/24	20	50	
4/24	40	60	
4/24	..	..	50
4/25	16	35	
4/25	20	50	
4/26	20	50	
4/26	30	40	
4/30	15	40	
Total	181	378	50

SUMMARY

Our experience and conclusions may be summed up as follows:

Ten cases of epidemic cerebrospinal meningitis were treated. Two men died, one an extremely fulminating case, who lived less than twelve hours after the onset and who received an intraspinal treatment of 2 c.c. of antimeningococcus serum; the other, an unrecognized and untreated case in which the man lived sixty-seven days, and in which diagnosis was either a syphilitic or tuberculous meningitis, and in which necropsy revealed a walled-off meningococcus infection of the brain.

The physical signs at the onset; that is, when first examined at the hospital, were as follows:

Kernig sign was present in 5 cases, or 50 per cent.; opisthotonos was present in 3 cases, or 30 per cent.; orthotonos was present in two cases, or 20 per cent.; delirium was present in 6 cases, or 60 per cent.; headache was present in 8 cases, or 80 per cent. (in the

other two cases the history was not obtainable); fever was present in eight cases, or 80 per cent. (in four of these cases the temperature was 104 or more).

The pulse was slow in comparison to the temperature, only one case showing the pulse above 103. Respirations were slightly increased. In 5 it was 20, and the other 5 ranged from 22 to 30. Vomiting was present in 6 cases, or 60 per cent. Lumbar puncture showed a cloudy fluid in 7 cases, or 70 per cent. In 3 cases, or 30 per cent., it was clear. A chill occurred in 3 cases, or 30 per cent.

During the course of the disease, the following findings were recorded: Serum sickness occurred in every treated patient except two, and one of these lived only four hours after his first treatment. The other patient was a negro, and he developed pain in ankles and testicles, and there was no rash. Of the six cases in which opisthotonos was absent at the onset, it developed later in two. Orthotonos was a common feature.

Of the five cases in which the Kernig sign was absent at the onset, it developed in two. Herpes labialis occurred in three cases, or 30 per cent. Purpura and rash, except that from serum sickness, was absent in all cases. The "spotted" rash described as one of the features of this disease did not occur in any of our cases. Three patients, or 30 per cent., required catheterizing. All patients ran a febrile temperature.

CONCLUSION

In conclusion, we would like to emphasize the following points: The cases here reported showed no uniformity of symptoms or signs. Marked variations of symptoms was the rule. Those symptoms and signs which in our cases appeared with the greatest uniformity were as follows: headache 100 per cent., fever 80 per cent., delirium 60 per cent., vomiting 60 per cent., Kernig 50 per cent., opisthotonos 30 per cent., orthotonos 20 per cent.; but no cases presented the hemorrhagic spinal "spotted" rash. In connection with the latter we have questioned whether the early administration of serum prevented the meningococcus from producing widespread toxic effects. Certainly, the prompt improvement following administration of serum supports such a theory, as indicated by the majority of our cases. If the "spotted" rash heretofore described as characteristic of this disease is due to hemolysis from an associated hemolytic streptococcus, one would be disposed to conclude that its absence in those patients treated early was due to the prevention of toxemia. If the petechial rash were due to septic emboli, these too would be associated with a similar toxemia checked by early serum treatment. Two of our patients showed no signs except fever and delirium.

The early diagnosis of this disease is of the greatest importance, as danger of infection of others is thereby lessened, and by early treatment the patient has the best chance of recovery. In many cases, early diagnosis is only possible by lumbar puncture and examination of the spinal fluid. Therefore, all doubtful cases should receive lumbar puncture, which, if properly done, is a comparatively simple, and a relatively safe procedure. Cases of fever and delirium with no other physical signs should have this done. When performing a lumbar puncture, *one should have everything ready to administer serum. If the spinal fluid is cloudy, or if clear with physical signs of meningeal involvement, give 20 or 30 c.c. of antimeningococcus serum.*

Not only is early treatment important, but intensive treatment should be started at once. Two intraspinal treatments of from 20 to 30 c.c. should be given every twenty-four hours. The intraspinal treatments should be given thus for the first few days, and decreased as the patient improves clinically.

As to the use of intravenous treatment, while we do not feel justified in drawing any conclusions, our feeling has been that all patients who come in with marked toxic symptoms, and all who are doing badly, should be thus treated. Fifty or 60 c.c. are given intravenously as often as once in every twenty-four hours, following the method of Cole. Very commonly a chill, followed by a rise of temperature to 103, 104, or even 105, occurs, but this is often followed by a drop to normal or even subnormal, and should cause no alarm. Herrick* reported the successful use of intravenous meningococcus serum at Camp Jackson. Herrick's report brought out valuable discussion to which the reader is referred.

Case 8 indicates that the intravenous treatment will at times bring about favorable results when the intraspinal method seems to fail.

As to when all serum therapy should be discontinued, it is very difficult to decide. In this connection the temperature is of practically no value as a guide. Normal or subnormal temperature may be present at the onset or during the first few days, while fever may be due to the effect of the serum. The two most reliable guides are the *spinal fluid* and the *general condition of the patient*. Treatment should not be discontinued until the spinal fluid is clear and free from meningococci, and not until the patient is clearly in much better condition, free from delirium and toxic signs. Serum sickness, which was present in practically all of our cases, may cause headache and fever and be mistaken for actual symptoms of the disease itself. The presence of a rash, usually urticaria, and pain in the joints, will often serve to differentiate the two.

* Proceedings of Assn. Am. Phys., May, 1918, to be published.

A safe way is to omit serum treatment for one day, then for two days, and if the patient continues to improve, discontinue it entirely.

One thing to bear in mind is that serum is the only method of treatment, and that if properly administered it cannot cause any permanent symptoms. Serum sickness is not a contra-indication to further treatment. Therefore, give serum as soon, as frequently, and in as large doses as possible.

The method of serum administration we used was as follows: The patient lies on his side, with his back at the edge of the bed. The knees and hips are flexed as far as possible, and the back bowed out. Opisthotonos increased the difficulty of successful puncture. Often $\frac{1}{4}$ grain of morphin, one-half hour before treatment would relax and quiet the patient. In some cases it was necessary to use chloroform. The operator should wear gloves to protect both himself and the patient. The amount of fluid that should be removed varies not only in individual cases but in the same case from day to day. "With the spinal fluid under pressure I (Bowman) have twice removed 70 c.c. in twenty-four hours. In some cases with decreased pressure, I (Bowman) have been unable to remove more than 12 c.c. because of the patient's complaining of such excruciating headache." In these latter cases, injection of the serum immediately caused a disappearance of the headache. Usually from 20 to 30 c.c. of serum was given intraspinaly, 40 c.c. being the largest dose. If the serum would not flow freely, slight pressure from a syringe was used to force it in.

For the extreme delirium, morphin and chloral may be used freely. When one realizes the energy a restless, delirious patient uses up every twenty-four hours, and the long-drawn-out character of the disease in some cases, it seems wise to save the patient's energy as well as to make him comfortable by the use of these drugs.

The diet must not be neglected. It is common to order "liquid diet" for febrile and delirious patients. The high caloric diet as in typhoid should also be applied to meningitis. We found that one overactive, delirious patient who was twisting and turning in bed night and day and talking incessantly, was using twice the energy of the average well man, and was receiving less than 1,000 calories a day. After a conference with our dietitian, Miss de Garmo, a special diet was arranged for all our patients, which, of course, varied a great deal in individual cases, but which averaged from 2,000 to 2,500 calories. Attention to or neglect of this may turn the scale in desperately ill patients.

Bladder distention should be watched for in all delirious patients. In one of our cases, incontinence with retention occurred, and was

DATA OF AUTHORS' CASES

	Case									
	1	2	3	4	5	6	7	8	9	10
Kernig at onset.....	0 developed later	+	+	0	0 developed later	0	0	++	+	+
Opisthotonos at onset.....	0 developed later	0	+	0	0 developed later	0	0	++	+	+
Orthotonos.....	0	+	..	0	+	0	?			
Temperature at onset.....	104.6	100.0	101.0	104.0	104.0	100.2	99.0	97.6	100.4	104.0
Pulse at onset.....	100	102	116	88	80	54	80	76	80	86
Respiration at onset.....	28	22	30	24	24	20	20	20	20	20
Delirium at onset.....	0 later	0	+	+	+	+	+	+	0	?
Headache at onset.....	+	+	+	+	+	?	?	+	+	+
Vomiting at onset.....	+	0	+	0	0	0	+	+	+	+
Serum sickness.....	+	+	+	0	+	+	0	+	+	?
Appearance of fluid at first puncture.....	Clear	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	Clear	Clear	Cloudy	Cloudy
First puncture-- Cell count.....	7,500	8,000	?	8,000	5,000	Pus	180	50	6,100	400
Globulin.....	++	+++++	+++++	+++++	+++++	+++++	++	0	++	++
Smear.....	Menin. (87% Poly.) Hay bac.	Many paramenin.	Menin. + No growth	Menin. + Menin. +	Menin. 0 Menin. 0	Menin. 0 Menin. 0	Not done Not done	Menin. 0 Menin. +	Menin. + Menin. 0	Menin. + Menin. +
Amount serum given, C.c.	232	114	168	20	675 S. + 295 V = 980	145 S. + 115 V = 260	0	274 S. + 50 V = 324	130	181 S. + 50 V = 231
Number of treatments.....	11	6	9	1	33 S. + 6 V = 39	7 S. + 2 V = 9	0	13 S. + 1 V = 14	6	8 S. + 1 V = 9
Outcome.....	Cured	Cured	Cured	Died	Cured	Cured	Died	Cured	Cured	Cured
Herpes.....	+	+	0	0	0	0	0	0	0	0
Chill at onset.....	+	Chilliness	0	?	0	?	0	0	0	+

only relieved by catheterization. Attendants and nurses should be cautioned to report slight incontinence of urine, as it may be an important index of retention. The urine should be carefully measured. In delirious cases, retention of urine may greatly add to the restlessness of the patient.

An accident which occasionally occurs is the *breaking of the needle* in the spinal column. This occurred in one of the earlier cases treated at this hospital, and has occurred at other military hospitals. In our case a subsequent operation successfully removed the fragment of the needle and at no time were there any ill effects. This risk is now overcome by using a needle made of a metal which is *bendable* but not breakable.

It has been found helpful to place on the wall *in consecutive order* the temperature charts, record of serum and blood examination and the daily record of calories taken and the amounts of serum given. This is a simple clinical point, but when the fight with the disease is at its height, the map of the operation offers a quick and graphic way of determining how the fight is going and enables the physician to direct his forces.