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MENINGOCOCCIC MENINGITIS AND EPIDEMIC MENINGO-ENCEPHALOPATHY

REPORTS OF ONE HUNDRED AND TWENTY-TWO ADDITIONAL CASES IN THE INDIANAPOLIS EPIDEMIC AND OF SIXTY-EIGHT CASES OF AN EPIDEMIC MENINGO-ENCEPHALOPATHY

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A clinical study of one hundred and forty-four cases of meningococcic meningitis, occurring during the first four months of an epidemic which began in Indianapolis in November, 1929, and in which practically all patients were admitted to the isolation wards of the City Hospital, was reported in *The Journal of the American Medical Association* for Sept. 13, 1930.[1] The conspicuous clinical features then observed, apart from involvement of the central nervous system, were the extreme virulence of the organism, the marked evidence of systemic infection and the death of the patients, despite rapid improvement in the changes of the spinal fluid. The high incidence of petechial hemorrhages and the large number of positive blood cultures, 63.8 per cent, were indications of the presence of a blood stream infection, and there was an apparent parallelism between the mortality rate and the number of patients with petechiae and positive blood cultures. In twenty-five of the cases showing petechiae either the patients died before blood cultures were obtained or the cultures taken were reported contaminated with a staphylococcus.

At intervals, cultures of the meningococcus isolated from the blood and spinal fluid were selected at random and typed by means of agglutination and absorption tests; they were found always to conform to type III. From clinical, bacteriologic and pathologic studies there was no doubt that the disease was epidemic cerebrospinal meningitis, caused by the typical gram-negative Diplococcus intracellularis meningitidis of Weichselbaum. (Cultures of this organism were sent to the United

From the Lilly Laboratory for Clinical Research, Indianapolis City Hospital, and the Department of Medicine, Indiana University School of Medicine.

1. Smithburn, K. C.; Kempf, G. F.; Zerfas, L. G., and Gilman, L. H.: Meningococcic Meningitis, J. A. M. A. **95**:776 (Sept. 13) 1930.

States Public Health Service.) This epidemic has continued, and the purpose of this paper is to present a study of cases since April 1, 1930, and the sequence of events in another epidemic, apparently different in character, which has either paralleled or grown out of the previous one.

From April 1, 1930, to Sept. 1, 1931, as indicated in figure 1, there occurred one hundred and twenty-two cases, with an average mortality rate of 73.7 per cent. The mortality curve will be seen to follow the number of cases closely; the type of case remained essentially the same. During the second year, however, there had been a decrease in the number of cases with petechiae and there was less evidence of systemic involvement. The serum used during the second year contained the Shwartzman [2] principle, and was from immunized horses which had been given additional strains of meningococci isolated during this epidemic.

The history of previous epidemics led us to expect a decrease in the mortality rate during the second year, even though only commercial brands of serum were available. During the latter part of September and October, 1931, six cases of a fulminating type, characterized by progressive epileptiform convulsions, were seen. The convulsions continued after coma and until death, which occurred within from twenty-four to forty-eight hours after the onset. At autopsy, the only gross finding in the brain was a slight grayish exudate with a few whitish yellow spots, about the size of a pinhead, involving the arachnoid and pia mater, and marked congestion of the cerebral veins. Grossly, there were no pathologic lesions in the parenchymatous organs. Direct smears from beneath the arachnoid in each of the six cases showed a gram-positive micrococcus. Similar organisms were found in smears taken from the brain in a case in which a spinal puncture had not been done, thus excluding their introduction by this procedure. Cultures from the brains of four patients revealed a similar organism. They were also obtained from the heart blood of one patient and from the liver and spleen of two others. Similar organisms were obtained by direct smear and by cultures of the spinal fluid of several patients, some of whom were thought to be suffering from tuberculous meningitis and others from meningococcic meningitis.

On checking over the spinal fluid smears and cultures and the blood cultures from the beginning of the epidemic, we found that a gram-positive organism had been frequently reported as a contaminating staphylococcus. In March, 1931, two children from the same family died of meningococcic meningitis, as shown by smear and culture, and a third child had died before the spinal fluid could be obtained. The grandmother and another older child were brought in for observation because of severe headaches. Spinal fluid cultures from both showed a gram-positive organism; globulin was present, and one had a cell

2. Shwartzman, Gregory: Therapeutic Antimeningococcus Serums, J. A. M. A. **93**:1956 (Dec. 21) 1929.

count of 34. In October, 1931, a cousin of the children came in with symptoms of cerebrospinal meningitis, but had a clear spinal fluid under slightly increased pressure. A gram-positive organism, which was not a meningococcus, was found in the spinal fluid. Later, there were two other instances in which there was a family relationship between patients with this type of illness and those with meningococcic meningitis of the previous year. Several other cases showed a relationship to the original source of the meningococcic epidemic.

Figure 1 shows the number of cases with gram-positive and gram-negative organisms; both organisms were present quite frequently in a single case. After the administration of antimeningococcic serum had made several patients definitely worse, it was given only when a meningococcus was recovered, when the patient showed petechiae or when a definitely cloudy fluid was obtained at the first spinal puncture. Serum was discontinued about Oct. 15, 1931; the mortality rate dropped immediately and has continued under 40 per cent.

From Sept. 22, 1931, to April 22, 1932, only seven patients with definite meningococcic meningitis were admitted to the Indianapolis City Hospital. Six of them showed petechiae and severe systemic symptoms, and all were acutely ill. Four recovered after receiving a commercial brand of serum intravenously, intraspinally and intramuscularly, and one died; the other two died before serum could be administered. This small group of cases during a period of six months illustrates the decline in the number of typical meningococcic cases during the winter months and indicates that the serum was effective.

A report of the first sixty-eight cases, in which only a gram-positive organism appeared, follows:

CLINICAL DESCRIPTION

The incubation period and the mode of infection in this type of case is not known, but the frequency of infections of the upper respiratory tract indicates that this may be the route.

Fulminating Cases.—These have usually been ushered in by a "cold," severe headache, nausea, vomiting and some vertigo or visual disturbances, followed by convulsions which came on within from a few hours to a few days after the first complaints. The temperatures have been subnormal, normal or, more frequently, rapidly rising. Pulse rate and respirations have been rapid immediately following a convulsion, but between convulsions they have been relatively low. Pupillary inequality with fixation on one side, strabismus and nystagmus were frequently present. The convulsions continued usually at close intervals as the patients sank rapidly into coma and died in from twelve to forty-eight hours. The seizures were epileptiform; they frequently began on one side (usually the right) but involved the entire body. Between con-

vulsions the muscles were spastic—usually more so on the side of onset of the convulsions; some twitching usually continued in the intervals. These patients, even the older ones, frequently sucked their tongues, but never bit them. The same or opposite side of the face might be

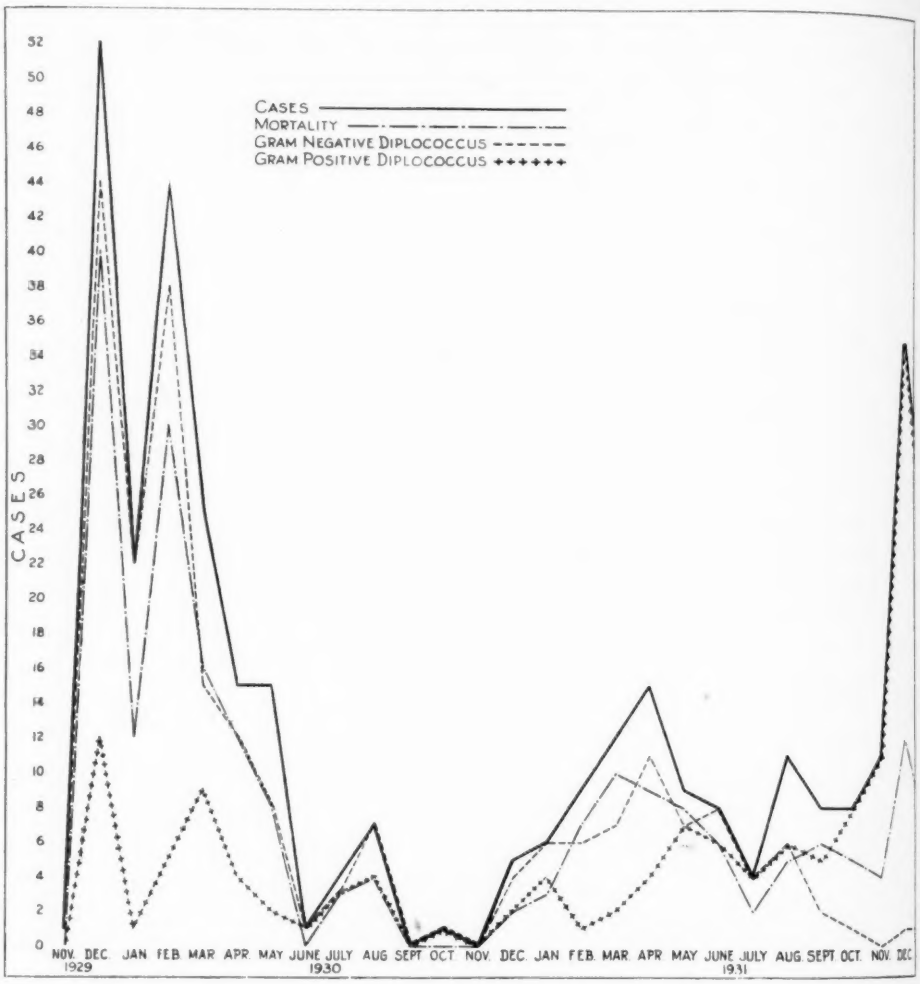

Fig. 1.—Cases are charted in the month in which the patients contracted the disease. The mortality curve represents, in that particular group, the number of patients who died. The gram-negative organism is the meningococcus. Since Sept. 27, 1931, the gram-positive organism has been studied culturally. The charting of the gram-positive diplococcus before that date indicates the number of times that a gram-positive coccus or staphylococcus was reported by the laboratory. Needless to say, since they were regarded as contaminants, their cultural characteristics were not studied, and they are charted only to show the frequency with which they appeared.

involved in the twitchings preceding the convulsions. The deep reflexes were hyperactive; Babinski's sign and ankle clonus were often present. There was little rigidity of the neck, but the patients retracted their heads if turned on their sides. Flexion of the head often revealed spasticity and caused pain. The abdominal and cremasteric reflexes were nearly always absent. Kernig's sign was difficult to elicit and, when present, was slight. The spinal fluids were clear, the pressures normal or lowered, and the blood pressure generally only slightly, if at all, elevated.

TABLE 1.—*Early Symptoms and Signs, Temperatures and Spinal Fluid Pressures in Sixty-Eight Cases*

	Per Cent		Per Cent
Onset:		Spasticity	30.0
Sudden	39.0	Strabismus	13.2
Week or less	35.0	Nystagmus	12.0
More than a week	26.0	Brudzinski's sign	12.0
Headache	66.0	Ankle clonus	12.0
Photophobia	60.0	Babinski's, Oppenheim's or Gordon's signs	7.3
Infection of upper respiratory tract	58.0	Patellar reflexes:	
Vomiting	36.1	Normal	22.0
Anorexia	33.0	Diminished	22.0
Strawberry tongue	33.0	Absent	23.0
Convulsions	28.0	Hyperactive	33.0
Pain in back and legs	25.0	Abdominal reflexes:	
Vertigo	20.0	Absent or diminished	66.0
Coma	25.0	Normal	34.0
Somnolence	20.0	Arm tendon reflexes: diminished	45.0
Irritability	20.0	Absent cremasteric reflexes	20.0
Irrationality	19.0	Spinal fluid pressure:	
Stupor	13.0	Increased	42.0
Convulsive tremors	9.0	Normal	29.0
Mania	6.0	Decreased	29.0
Delirium	6.0	Variable (during illness)	60.0
Abdominal pain	8.0	Temperature:	
Adenopathy	7.0	Below 98 F.	7.3
Nausea only	6.0	From 98 to 100 F.	38.2
Herpes	3.0	From 98 to 102 F.	22.0
Rash	3.0	Above 102 F.	32.3
Emaciation	3.0	Positive Wassermann reaction	12.0
Neurologic findings:		Gold curves in 28 cases:	Cases
Tendency to lie with head retracted slightly	78.0	Normal	4
Pain on flexion of head or neck	66.0	Tabetic	6
Rigidity of neck	57.0	Dementia paralytica	18
Kernig's sign	40.0		
Abnormal pupillary reactions	35.0		

Less Acute Cases.—The onset was usually slower, sometimes lasting a week. The prodromal symptoms were often an infection of the upper respiratory tract, severe headache, pain in the back and legs, irritability, anorexia, slight nausea and, occasionally, vomiting. The psychic disturbances exhibited by these patients varied in the direction either of heightened irritability or of mental dulness. Patients with the less acute type of illness sometimes suddenly became maniacal, lost consciousness, had a convulsion or became very drowsy. Convulsions were not continuous and were not often repeated after spinal drainage. Photophobia, when present, was slight; strabismus, nystagmus and pupillary inequalities were frequently seen. Examination of the eyegrounds revealed

only a slight papilledema in some cases. This type of patient was more apt to show rigidity of the neck, and always retracted the head slightly when lying on the side; Kernig's sign was more often present; the deep reflexes were sometimes normal, but more frequently were diminished or absent. The abdominal and cremasteric reflexes were almost always absent or diminished, but in one case they were markedly hyperactive; hyperesthesia was occasionally observed in children. A "strawberry tongue" was frequently seen in the average case. The temperature varied from 98 to 102 F., except in children, in whom it was usually much higher. Compared with the temperature, the pulse rate was apt to be somewhat slowed in adults, but in children the rate was usually much higher. The respirations were slower than might have been expected from the general appearance and temperature of the patient. One patient had tetanic convulsions, another paroxysms simulating those of rabies; both were conscious during the attacks. A few of the patients had a mucous diarrhea, and several complained of a severe abdominal pain. Bladder symptoms or incontinence of urine and feces was seen only when the patient was in a stupor or coma. On arousing after spinal drainage, these patients frequently passed through a period of mania.

Milder Cases.—The onset was insidious or, more probably, the condition was not recognized. Infection of the upper respiratory tract, headache, blurring of vision, irritability, hallucinations, delusions, mild paranoia and schizophrenia or mania, gradually becoming worse over a period of weeks, were characteristic. The meningeal symptoms were relatively mild, with deep reflexes normal or only slightly changed, and abdominal reflexes frequently diminished or absent. Many of the patients were admitted first to the psychopathic ward, where a diagnosis was made from the results of routine serologic examinations. Most of the patients improved remarkably after daily spinal drainage. Several psychopathic patients contracted the disease through contact with other patients in whom it had been unrecognized; in them the mental symptoms naturally did not improve.

Of the first sixty-eight cases, twelve were fulminating, thirty-five less acute, and twenty-one mild.

REPORT OF CASES

CASE 1.—D. H., a white boy, aged 6 years, who was admitted on Sept. 22, 1931, was known to be epileptic; he had been receiving phenobarbital and had not had convulsions for two months, when he suddenly passed into convulsions which continued for two hours and were controlled with sodium amytal. After twenty-four hours, he was still unconscious; he was spastic (especially on the right side), and had some rigidity of the neck, a positive Kernig sign and a divergent strabismus. The temperature was 105.6 F. and continued to rise until death. An attempt to make an examination threw the child into convulsions, which began on the right

and became generalized. The child sucked its tongue instead of biting it. He died twenty-seven hours after the onset. The spinal fluid was clear; the cell count was normal, smears gave negative results, and the pressure was slightly increased. Autopsy revealed a congested brain with a slight grayish exudate over the vertex, a gram-positive diplococcus on direct smear and nothing else to account for death.

CASE 2.—C. H., an exceptionally well developed and well nourished colored man, aged 19, was admitted to the Indianapolis City Hospital, on Sept. 23, 1931, in epileptiform convulsions that continued as he went into coma and until death, fifty-two hours after the onset. He had felt bad, and had had a convulsion two days before being admitted. The blood pressure was 154 systolic and 48 diastolic; the urine was normal. The spinal fluid was not under increased pressure; the cell count was 2; globulin was one plus, and a smear gave negative results. The temperature rose steadily to 107 F. before death. The convulsions in this case began on the right and became generalized. The patient sucked his tongue but did not bite it. At autopsy there were no gross changes in the parenchymatous organs. The brain was congested and there was a grayish exudate over the vertex, direct smears from which showed a gram-positive diplococcus.

CASE 3.—E. P., a well developed and well nourished white woman, aged 42, previously healthy, who had been ill for a week, was admitted on Sept. 21, 1931, in an irrational state, with severe headache and stiff neck. She had a reddened throat, rigidity of the neck, pain on flexing the head, slight retraction of the head, diminished patellar reflexes, positive Kernig sign and a tender nodule on the right side of the neck which had been present for thirteen years. The patient cried and talked incessantly. Under antimeningococcic serum she remained irrational and the fluid remained cloudy. On three different occasions, because organisms were found in the spinal fluid, attempts were made to treat her with antimeningococcic serum, and in each instance the patient's condition grew worse instead of better. The patient responded to daily spinal drainage and was released Jan. 17, 1932.

The results of laboratory tests were as follows: urinalysis, 1 plus albumin; blood culture, a gram-positive micrococcus on Sept. 22, and on Oct. 25, 1931; red blood cell count, 3,500,000 on Oct. 1, 1931, and 2,940,000 on Oct. 16, 1931; white blood cell count, 12,000 and 12,550; colloidal gold curve on Nov. 18, 1554325321, on Nov. 28, 55554321111, and on Dec. 1, 1931, 5544433110; Wassermann reaction of the blood and spinal fluid, negative; globulin, from 0 to 4 plus; cell count, from 0 to 4,356; spinal fluid smear, positive seven times; culture, positive forty-nine times; spinal fluid pressures, from 20 to 240; spinal fluid sugar, too low to read on admission; nonprotein nitrogen, 39.2.

CASE 4.—E. M., a well developed, well nourished, previously healthy, colored man, aged 19, was sent to the Indianapolis City Hospital from Franklin, Ind., on Oct. 2, 1931, with convulsive seizures simulating those of tetanus. He did not have abdominal rigidity, and a site of infection was not found. Before tetanus antitoxin was administered the spinal fluid, which was clear, had to be aspirated; the cell count was normal. The white blood cell count was 9,800, and urinalysis gave negative results. At this time the neck was not rigid, and Kernig's sign was negative, but the knee jerks were not obtained. The temperature ranged from 99.6 to 102 F. The patient was given tetanus antitoxin intraspinally and intravenously and was kept quiet with sedatives, but the seizures became worse, the temperature rose to 105 F. and then to 108 F., and he died at the end of five days. A gram-positive diplococcus was obtained on culture, and autopsy revealed a much engorged brain with a few small areas of subpial hemorrhage and a few whitish-yellow spots, about 2 mm. in diameter, especially along the sulci. A similar organism was obtained on smear and culture from the brain at autopsy.

CASE 5.—J. M., a well developed and well nourished colored man, aged 49, married and the father of several healthy children, without a previous history of epilepsy, was brought to the hospital after a convulsion on Oct. 31, 1931. He awakened and was discharged with a diagnosis of epilepsy. Two hours later, he was returned in a convulsion; two more occurred at fifteen minute intervals; during the third one he died. The spinal fluid was not under increased pressure; the cell count was 3; a smear gave negative results; the temperature was normal. A gram-positive diplococcus was grown from the spinal fluid. At autopsy, only a grayish exudate over the vertex of the brain was seen; the cerebral veins were engorged. Smears from beneath the arachnoid showed a gram-positive diplococcus. Cultures from the brain and heart blood revealed a similar organism.

CASE 6.—C. N., a white man, aged 39, well developed and well nourished, with a history of previous good health, had been extremely irritable for several days and had suddenly become maniacal. He was subdued by the police and admitted to the psychopathic ward, on Oct. 26, 1931, in acute mania with a seeming inability to swallow. A history of a dog bite was not obtained. After a few days he showed transient rigidity of the neck, positive Kernig signs, divergent squint, fixed pupils and normal eyegrounds. The thorax and abdomen were normal. On admission the temperature was 99.6 F., the pulse rate 100 and the respiration rate 24. After a few days of tube feeding and daily spinal drainage, the inability to swallow disappeared, the temperature became lower, and the patient appeared to improve mentally and physically. The organism obtained from the spinal fluid was gram-negative on the fifteenth day, and the patient was given antimeningococcic serum. On the next day the spinal fluid was cloudy, the temperature rose, and he rapidly became worse; he sank into coma and died on the seventeenth day. The temperature varied from 99 to 103 F. until two days before death, when it rose to 104 F. The white blood cell count was 11,300; the Wassermann reactions of the blood and spinal fluid were negative; the spinal fluid was clear and under increased pressure, and contained globulin; the urine was normal; a gram-positive micrococcus was cultured from six of eight specimens of spinal fluid drawn. Autopsy revealed a congested and swollen brain with a grayish appearance, and the arachnoid and pia were studded with numerous tiny yellowish plaques, particularly over the vertex. Cultures and smears from beneath the arachnoid revealed a gram-positive micrococcus.

CASE 7.—D. J. O., a well developed and well nourished white girl, aged 6 years, was admitted on Oct. 28, 1931, complaining of a stiff neck, headache, fever, backache, soreness of the muscles and fretfulness. This child had recovered from pertussis five weeks before and had had a cold since. Four cousins and the grandmother had been ill in March, 1931, with meningitis. The nasal mucosa and tonsils were inflamed; the reflexes were normal; there were rigidity of the neck, pain on flexing the head and a positive Kernig sign. The child was drowsy but not very ill. The temperature was 101 F., the pulse rate, 144 and the respiration rate, 28. The spinal fluid was clear and under slightly increased pressure, with a cell count of 100 and globulin 2 plus. Culture showed a gram-positive micrococcus, which was present in smear and culture for the next two days. Later, the patellar reflexes became hyperactive, Brudzinski's sign was positive and an enteritis developed with mucous stools. The patient was discharged from the hospital thirteen weeks after admission. The temperature ranged from 97 to 103.2 F., the pulse rate from 74 to 156 and the respirations from 20 to 38. The laboratory findings were: red blood cells, 3,700,000; white blood cells, 23,300; blood culture, negative; nonprotein nitrogen, 32.9; spinal fluid pressure, from 0 to 260 mm. of water; cell counts of the spinal fluid, from 0 to 5,732; globulin, from 0 to 4 plus; positive

smears from the spinal fluid, 5; positive cultures, 35. She received antimeningococcic serum once. The colloidal gold test showed these curves: on Nov. 18, 1931, 1223331100; on Nov. 28, 5555531211, and on Dec. 1, 4414332200.

CASE 8.—L. N., a well developed and well nourished white girl, aged 2 years, who had had pertussis and dysentery two months before but had been otherwise healthy, had a convulsion, with fever, three weeks and again two weeks before admission on Nov. 11, 1931. She cried out during sleep and while urinating. Examination revealed hyperesthesia, slightly retracted head, pain on flexion of the head, diminished patellar, biceps and abdominal reflexes, a positive Kernig sign, a coated tongue and an inflamed throat. During her stay in the hospital, the child vomited and a sustained ankle clonus developed. She improved steadily after the forty-ninth day and recovered completely. On admission she had a temperature of 99.5 F., a pulse rate of 100 and a respiration rate of 22. The temperature ranged from 97.5 to 104 F., the pulse rate from 80 to 140 and the respirations from 14 to 30. There was a trace of albumin in the urine. The spinal fluid pressure varied from 0 to 260, the cell count from 0 to 45 and the globulin from 0 to 4 plus. Organisms were not found on direct smear, but were recovered on culture of the spinal fluid sixteen times; the serology was negative.

CASE 9.—J. R. S., a previously healthy colored boy, aged 2½ years, was admitted in convulsions on Nov. 25, 1931. The temperature was 98.2 F., the pulse rate 156 and the respiration rate 30. There were: nystagmus, fixed pupils, clonic spasms of the right side of the face, sucking of the tongue and spasticity of the entire right side, with occasional convulsions arising from this side and spreading to the entire body. The Kernig sign was positive on the right, and suggested on the left; the Brudzinski sign was positive; the patellar reflexes were present, and ankle clonus was obtained on the right. The spinal fluid was clear and under a pressure of 100 mm. of water; the cell count was 20; globulin was 4 plus. The convulsions continued throughout the night; the child became spastic, and showed a bloody exudate from the nose and mouth before death, which occurred thirteen hours after admission. A gram-positive diplococcus was cultured from the spinal fluid. Autopsy revealed marked engorgement of the cerebral vessels. The organism was not found on direct smear from the brain, but was cultured from the spleen and liver.

CASE 10.—D. G., a well developed and well nourished white man, aged 20, who had been previously healthy, suffered from severe headache, which was not controlled by morphine, for a week. On admission on Nov. 11, 1931, the ears and sinuses were normal; there was pain on flexing the head; Kernig's sign was positive; the tongue was furred; the abdomen was distended; abdominal and patellar reflexes were diminished; photophobia was present, and the head was slightly retracted with the knees and thighs flexed. The temperature was 101, the pulse rate 60 and the respiration rate 22. The spinal fluid was clear; the pressure was 240 on admission and varied from 70 to 360 mm. of water; the cell count varied from 39 to 288; globulin was present, from a trace to 3 plus; the white blood cells numbered 8,100; the urine was normal; the nonprotein nitrogen was 34.5; there was a slight change, in the tabetic zone, in the colloidal gold curve. During the first four days the pulse rate remained around 60, rising as high as 80 after spinal drainage, and dropping as low as 40. The patient was discharged on Dec. 18, 1931, and there have been no sequelae. A gram-positive micrococcus was found three times on direct smear and nine times on culture of the spinal fluid.

CASE 11.—H. H., a well developed and well nourished white boy, aged 10½ months, had had spasmodic coughing for two months, which was thought to have

been mild pertussis; he recovered from this, but with the continuation of a cold. Three days before admission on Dec. 3, 1931, he began to have tremors and jerky movements and to draw back his head. He vomited, was pale, stuporous and toxic in appearance and seemed hypersensitive. There were slight rigidity of the neck, a positive Kernig sign, hyperactive superficial and deep reflexes and slight patellar clonus, with nothing abnormal about the eyes, ears or chest, but with slight abdominal distention. On admission the temperature was 97.8 F., the pulse rate 120 and the respiration rate 26. The spinal fluid was clear; the pressure was normal; globulin was present, and a culture gave negative results. On the second day, a smear and culture from the spinal fluid gave positive results. The child seemed to improve after the second week, during which he had several convulsions. On the twenty-first day, the temperature dropped to 96.5 F. and the pulse rate rose to 150; the child became unconscious and cyanotic, and died. A gram-positive micrococcus was found once on direct smear and twelve times on culture. It was found by incubating the spinal fluid itself. The spinal fluid pressure varied on different days from 0 to 230 mm. of water; the globulin varied from 2 to 4 plus, the cell count from 0 to 450. The temperature ranged from 96.5 to 103.2 F.; the pulse rate from 95 to 155, and respiration rate from 12 to 64. The colloidal gold curve was 555532210; the Wassermann test was negative.

CASE 12.—J. C., a previously healthy, well developed and well nourished white boy, aged 2½ years, became fretful, cried and had two convulsions shortly before admission on Dec. 24, 1931. There was no ocular involvement; there were slight rigidity of the neck, slight opisthotonos, distention of the abdomen, a suggested Kernig sign, hyperactive patellar reflexes and diminished arm tendon, epigastric and upper and lower abdominal reflexes. Eight days later, the patellar reflexes were still hyperactive; the Kernig sign was positive, and there was bilateral ankle clonus. The temperature on admission was 103 F., the pulse rate 130 and the respiration rate 32. The temperature, pulse rate and respiration rate dropped after drainage. The temperature ranged from 98 to 103 F., the pulse rate from 130 to 86 and respirations from 36 to 20; urinalysis gave negative results, and the spinal fluid cell count varied from 0 to 18. An organism was not found on direct smear, but was recovered on culture three times; the globulin was from 0 to 4 plus. The patient was discharged as recovered on Jan. 22, 1932.

CLINICAL COURSE

Patients in the fulminating cases continued in convulsions, became comatose and died from twelve to forty-eight hours after the onset. Occasionally a patient with a severe case improved after spinal drainage and the intravenous administration of dextrose. The temperature in most patients of this type rose rapidly to as high as 108 F. or dropped below normal—in one instance going as low as 94.5 F.

In the less severe type the patients improved rapidly after spinal drainage and frequently came out of stupor or coma after one or two punctures. (Rachicenteses were done with needles of regulation size, and the fluid was allowed to escape until the pressure was below 50 mm. of water.) In these patients the temperature, if elevated, rapidly approached normal after one or more spinal drainages. The course then showed little fever and few symptoms unless drainage was stopped. Even when the spinal fluid pressure was normal or low, drainage

relieved the severe headaches from which the patients suffered. In a few of the first cases in which drainage was discontinued and the patient was allowed to get up, severe symptoms, such as headache, vertigo, nausea or vomiting and elevated temperature, followed and were again relieved by spinal drainage. The principal indications for this measure, which was continued every other day or oftener, were: an abnormal pressure at the preceding puncture, severe headache, vertigo, nausea, elevated temperature, marked changes in the pulse rate, drowsiness, irritability, coma, increased retraction of the head, rigidity of the neck, a positive Kernig sign or changes in the deep reflexes. The patients continued to be watched as long as they exhibited such symptoms or until cultures of the spinal fluid or blood were repeatedly sterile. Some of the patients in coma passed through a period of mania on arousing. A few continued as they were or showed only slight improvement and died in from five days to a month.

TABLE 2.—*Distribution of Cases According to Age, Sex and Color, with Mortality by Decades*

	1-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80	Total
Number of cases	16	3	8	13	10	8	9	0	1	68
Per cent of cases	23.5	4.4	11.8	19.1	14.7	11.8	13.2	0	1	100
Deaths	7	2	2	5	4	3	3	0	1	27
Per cent	44.4	66.6	25.0	37.4	40.0	37.5	33.3	0	100	Av. 39.7

	Males	Females	White	Negro	Youngest	Oldest	Less Than 1 Year
Number of cases	54	14	46	22	4.5 mos.	81 yrs.	3
Per cent	80	20	68	32			

The time spent in the hospital by patients who recovered varied from eleven days to four months. Most of those who survived the first week recovered; only one died after more than a month of illness. These patients, except when stuporous or in coma, did not refuse food and fluids, and only occasionally did one show a tendency to become emaciated. The mortality rate for the first sixty-eight cases was 39.7 per cent; it has since continued below 40 per cent.

COMPLICATIONS AND THERAPY

Several of the first patients who exhibited rather definite meningeal symptoms simulating meningococcic meningitis were given antimeningococcic serum intraspinally. After a few treatments, these patients became definitely worse—even to the point of extreme danger—with a rise in temperature and an exacerbation of cerebrospinal symptoms. In one case this happened several times, and in another more than once, because a supposed meningococcus organism had been isolated from the spinal fluid. After several patients in whose spinal fluids these organisms were found had reacted in this manner, the serum was dis-

continued and was given only when the meningococcus was identified, when petechiae were seen or when the first spinal fluid was cloudy.

Of the first sixty-eight patients, bilateral optic atrophy developed in one before death, two had bronchopneumonia, one had a vegetative endocarditis and two had arthritis. There were no other complications that had not existed before the onset of the disease; in the last group, details of which are not included, there has been one case of paraplegia and one of monoplegia.

During the latter part of January and February, 1932, an epidemic characterized by respiratory and intestinal symptoms, commonly diagnosed as influenza, appeared in Indianapolis. During this time, eight patients with pneumonia, fibrinous pleurisy or empyema, as well as with the cerebrospinal symptoms exhibited by the other patients, were seen; six of them died. Before and since, these patients have been remarkably free from complications. The recovered patients have thus far not shown sequelae.

So far, with this group of patients, repeated spinal drainage, intravenous administration of dextrose, intravenous administration of physiologic solution of sodium chloride (when the patient could not take fluids), proper elimination, intravenous administration of salicylates, sedatives and a nutritious diet have been the only measures of definite value.

LABORATORY FINDINGS

The red blood cell counts have been essentially normal, with a few running as low as 3,500,000, and the hemoglobin has followed the red cell count. White blood cell counts have run from as low as 3,000 to as high as 50,000; the average has been from 15,000 to 20,000. Early in the course of the disease the polymorphonuclear leukocytes were apt to run from 70 to 80 per cent, but, as the disease progressed, there was a relative increase in the number of mononuclear cells, some of which were young lymphocytes and some monocytes, occasionally up to 50 per cent.

The urinary findings have been essentially normal, except for albumin, which was seen in the agonal stages; also in two patients with septicemia and in two who had had nephritis of long standing. The nonprotein nitrogen of the blood, when determined, has been normal except in two patients with nephritis, in whom it was below 100 mg. per hundred cubic centimeters.

The spinal fluid pressure has varied from 0 to more than 800 mm. of water; many patients have shown a marked daily variation between 0 and 500 mm. of water. The fluids have been clear, sometimes opalescent (a few shreds might be seen), and the pressures have been increased, normal or decreased at the initial puncture. The first cell count has been very low, varying from 1 to 200; in the majority of

cases it has been under 50, and in the most acute cases normal. After daily spinal punctures, the cell count has been as high as 400. The introduction of serum or any other intraspinal medication has always been followed by an increase in the cell count, once as high as 17,000. The predominating cell has been a mononuclear phagocytic cell. A few polymorphonuclear leukocytes and lymphocytes have also been present, but after intrathecal treatment the polymorphonuclear cells predominated. The globulin has varied from 0 to 4 plus, and has almost always been present.

Colloidal gold curves early in the disease have shown no change at all, or only slight changes in the tabetic zone. In some cases of more than two weeks' duration, the gold curves have shown increased changes in the tabetic zone but, more often, the changes were typically those of dementia paralytica; this was true when the patient had not received intrathecal medication. The Wassermann reaction of the spinal fluid has been negative or anticomplementary, except in instances in which a positive Wassermann reaction of the blood was also obtained. Two of the cases were suspected of being dementia paralytica, but the "dementia paralytica curve" has occurred in children under 1 year of age, as well as at all other ages, and in cases showing negative Wassermann reactions of the spinal fluid and blood. The Wassermann reaction of the blood has been positive in 12 per cent of the cases.

The spinal fluid sugar has varied from zero to normal early in the disease, and, as the patients improved, the low sugar content rose to as high as 80.

PATHOLOGY

Seventeen of the first twenty cases that came to autopsy [3] presented a slight serogelatinous exudate which gave the arachnoid a grayish appearance. This was particularly prominent in the sulci and along the blood vessels of the vertex. The meningeal veins and capillaries were much congested, particularly those of the arachnoid, giving the brain a reddened appearance, which was especially noticeable in children. In several cases there were also a few whitish-yellow, pinpoint spots and occasionally one or more, from 0.5 to 1 cm. in diameter, beneath the arachnoid. These did not appear to be tubercles. In some of the more prolonged cases the exudate was more marked and, in two of these, covered the whole cerebral surface. In several, there were small subpial hemorrhages which did not extend into the cortex and appeared to be the result of capillary oozing; in two, there were small subdural hemorrhages, but a ruptured vessel could not be seen, and they did not appear to be sufficient in themselves to have caused death; in two, small abscesses involving the cerebral cortex were found. The spinal cord,

3. Microscopic sections were examined by Dr. Elmer Funkhouser, formerly pathologist to the Indianapolis City Hospital.

in the cases in which it was examined, revealed chiefly a congestion of the vessels; however, one case, in which an abscess of the brain was present, also showed a serogelatinous exudate. One of the cases showed only a marked congestion of the meningeal vessels; the dura mater usually showed very little change. Two cases, one of them with an abscess of the brain, revealed miliary and larger abscesses in the parenchymatous organs, and one of these showed tuberculous lesions.

Microscopically, there were very few inflammatory cells in the meninges and in the brain substance, except in cases of more than two weeks' duration. The arachnoid and the pia had a cobwebby appearance with few inflammatory cells, most of which were macrophagic.

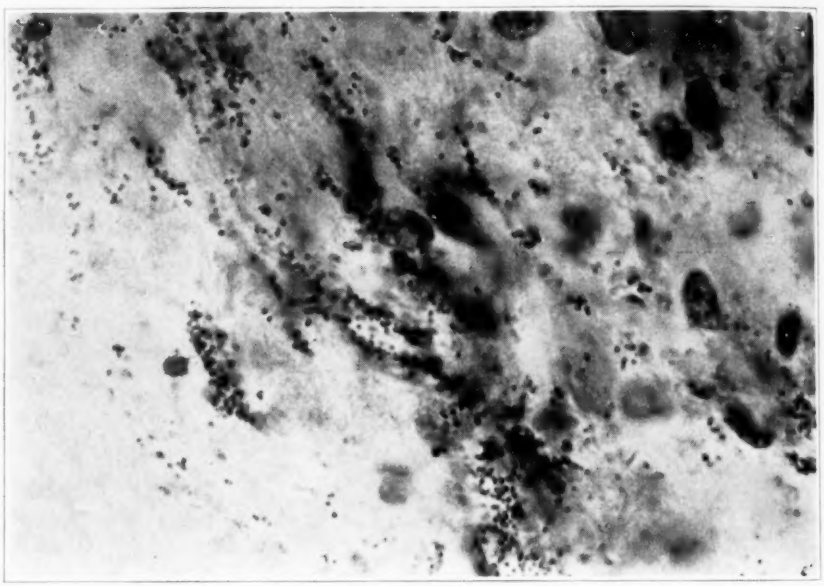

Fig. 2 (case 11).—Section of meninges. Toluidine blue; × 1,000.

More prolonged cases revealed a definite meningitis with areas of macrophagic and leukocytic reaction; numerous tiny micrococci were found in sections in one case. There was marked dilatation of the blood vessels, with little evidence of an inflammatory reaction about them. The ganglion cells, particularly those of the cortex, showed vacuolation and appeared to have been damaged by a powerful toxin. This was true even in the most acute cases. The brain substance, basal ganglia, medulla and cerebellum did not show evidence of an inflammatory reaction such as is seen in epidemic encephalitis or polioencephalitis.

The liver cells showed vacuolation, particularly about the central veins, and the cells of the convoluted tubules in the kidneys had frequently lost their intercellular markings and showed some degenerative

changes. These changes, the fragmenting of the heart muscle and the slight changes in the lungs, spleen and other organs were not different from those in any acute infectious disease.

BACTERIOLOGY

The associated organism usually appears as a gram-positive micrococcus, occasionally staining gram negatively, and varying in size from 0.2 to 1 micron in diameter. When first cultured from the spinal fluid or blood, or on direct smear at autopsy, it appears as a small diplococcus and may be brought out with Giemsa's stain when Gram's stain does not show it. On subculture, it shows a staphyloid grouping and occasionally appears in short chains. In old cultures it has the appearance of a staphylococcus, and in very old cultures, a small form; involution forms, which resemble bacilli, are frequently seen. The colonies are usually grayish white; young colonies are white and discrete, and older colonies frequently coalesce and show a yellow pigment. On solid mediums the colonies are moist and are readily picked up with the loop. Old cultures on liquid mediums frequently produce a pellicle or sediment. The organisms grow at room temperature.

These organisms have been found on direct smears taken from beneath the arachnoid in eighteen of twenty cases, at autopsy, and have been found on direct smear on at least one occasion from the spinal fluid of thirty-nine patients. They have been found on culture of the spinal fluid in all but one of the cases in this hospital, but not from every spinal fluid drawn. They have been noted repeatedly in the same case, but have not been found in culturing all spinal fluids drawn from other patients in the Indianapolis City Hospital as a routine during a period of more than four months. They have been found on blood cultures in twenty of thirty-seven cases and in one patient fifteen times; also on culture of material taken from the brain in sixteen or eighteen cases at autopsy.

The meningococcus has not been found in the spinal fluid or blood, or in the nasopharyngeal cultures from any of the patients in this group of sixty-eight cases.

The organism is difficult to grow on first culture, from forty-eight to seventy-two hours being required, but it grows readily on subculture. It may be grown on first culture in dextrose broth, but appears to grow more readily on a dextrose brain broth adjusted to p_H 7.5, and has been grown at p_H 8.2. It grows when the spinal fluid itself is incubated. With Andrade's indicator it produces acid but not gas from dextrose, maltose, lactose and saccharose, but with phenol red, mannite also shows acid; with Andrade's indicator it does not produce acid or gas on mannite, salicin or inulin. It is not bile soluble, does not produce indol, liquefies gelatin at room temperature and coagulates milk after several

days. On potato, the colonies are at first white or gray; then many of them gradually become yellow. Yellow pigment is also produced on Loeffler's mediums. The organism is slightly hemolytic on blood agar, but more so when frequently subcultured on blood mediums. It grows on plain broth or on plain agar, and it grows under ordinary anaerobic conditions.

Cultures in dextrose broth, brain broth and blood sugar and in the spinal fluid itself have remained alive for more than four months in the icebox, at room temperature (even when allowed to dry out) and in the incubator. All the strains appear to belong to the staphylococcus group, but there are differences in their pigment-producing power; some do not ferment mannite.

Agglutination tests have been hampered because, even when cultured on salt-free buffered mediums, the organism produces a viscid material which causes auto-agglutination in spite of washing. Further work on absorption, agglutination and precipitin tests is in progress.

The following measures have been carried out in attempting to rule out contamination: (1) All brain broth mediums have been sterilized at 7 pounds (3.1 Kg.) pressure for forty-five minutes on three successive days; (2) other mediums have been sterilized at 15 pounds (6.8 Kg.) pressure for thirty minutes; (3) the glassware and spinal puncture needles have been sterilized by dry heat at from 160 to 180 C. for two hours (sufficient to brown the cotton slightly); (4) uninoculated mediums from each batch were incubated along with the cultures; (5) cultures were taken from the walls and beds of the contagious ward, and culture tubes were left open on the bedside tables for from two to three minutes. Bacillus subtilis was the only organism found in any of these. Cultures from the sheets on which the patients were lying showed a gram-positive micrococcus in several cases. As spinal fluid had been spilled on these sheets in doing punctures and these patients sometimes had involuntary evacuations, and since the organism grows at room temperature, this was to be expected; (6) all cultures of blood and spinal fluid were drawn through dry iodine.

PRELIMINARY INOCULATIONS OF ANIMALS

Rabbits were inoculated intravenously, intraperitoneally and intracisternally with 1 cc. of broth cultures of several strains, incubated for from eighteen to twenty-four hours, without apparent results. Guinea-pigs and white mice, inoculated intraperitoneally, apparently did not become ill. Rabbits were inoculated intraperitoneally, intravenously and intracisternally with 1 cc. of fresh spinal fluid (in which organisms were seen on direct smear and from which they were later cultured) without causing symptoms. One cubic centimeter of material from and about an abscess of the brain in one case, given intravenously without

filtering to a rabbit, did not produce disease. After a strain from spinal fluid in case 11 had been repeatedly subcultured on blood agar, rabbits weighing 4 pounds (1.8 Kg.) could be readily infected by the intravenous injection of 1 cc. of a broth culture, after from eighteen to twenty hours. Positive blood cultures were obtained and a similar organism was recovered from the brain at autopsy. Although no conclusions can be drawn from results in rabbits, the symptoms—spastic paralysis of the fore and hind legs, spasticity of the neck, occasional convulsions, lowering of the temperature and marked slowing of the respirations in the terminal stages—were largely cerebrospinal. This procedure was repeated several times, and then the organisms were passed through one series of four and another series of three rabbits. The virulence in each series was enhanced, the last rabbits dying in from eight to ten hours, while the first lived for from three to ten days. This organism also killed guinea-pigs when injected intraperitoneally. Abscesses and free pus were not found at autopsy in these animals. When 1 cc. of a seventy-two hour culture of this organism was given intravenously, a rabbit weighing 4 pounds remained free from symptoms for about two weeks, and then gradually a spastic paralysis of the hind and fore legs developed. At autopsy all the lymph glands were caseated and several abscesses were found. Two other strains have proved pathogenic for rabbits and guinea-pigs.

Further studies with the various strains of this organism and with spinal fluid and blood from these patients, in rabbits and other more suitable animals, are in progress.

COMMENT

Our attention was directed to this type of case by the persistently high mortality rate among the cases of meningitis, the apparent deleterious action of antimeningococcic serum, the change in the clinical manifestations of the disease, its epidemic nature, the pathologic findings and the regularity with which a gram-positive micrococcus was recovered in cultures of the blood and spinal fluid. If this micrococcus is a contaminant, it is a most interesting one because of the frequency with which it appears, particularly in the small form, which is readily overlooked. In describing mixed infections in meningococcic meningitis, Elser [4] said that he occasionally found only a Staphylococcus albus; apparently, he considered it a contaminant. Mixed meningitic infections were described by von Lingelsheim [5] and others, who found Diplococcus crassus in cases of meningococcic, tuberculous and traumatic meningitis.

4. Elser, William J., and Huntoon, Frank M.: Studies on Meningitis, J. M. Research **20**:371, 1909.

5 von Lingelsheim and Leuchs: Klin. Jahrb. **15**:489, 1906.

The postmortem findings in several of Jaeger's [5] cases and the description of his meningococcus indicate that he may have been dealing with conditions similar to those of the present epidemic.

The epidemiology points toward the possibility that this organism may be one with little invasive power, which has grown symbiotically with the meningococcus. As the virulence of the meningococcus decreased, that of this organism appears to have increased, with the meningococcus simply preparing the way for an organism with little invasive power. That this organism, in itself, might have developed sufficient invasive power to cause disease is possible. The fact that the meningococcus could not be recovered from the blood, spinal fluid or nasopharynx does not necessarily mean that it was not there. However, it was readily recovered from the few meningococcic cases that we have observed during the last few months and during the first and second years of this epidemic. One might expect to find an organism of this nature in traumatic meningitis or as a complication in tuberculosis, neurosyphilis or other debilitating diseases.

During the first three months of 1932, a technician in our own department and two nurses on duty in the hospital contracted this disease. They had not in any way worked with the cultural material, but each of them had been in contact with several patients with this type of disease in the general wards. This is interesting because during the entire epidemic not a single physician, nurse or attendant contracted meningococcic meningitis. The three patients cited have recovered and have thus far not shown sequelae.

Whatever the rôle of this organism may be, its presence in cases of meningitis alone or with the meningococcus is a contraindication for the continued use of the meningococcic antiserum. To continue the intrathecal administration of antimeningococcic serum as long as organisms are found in the spinal fluid is dangerous, unless a meningococcus alone is present.

The organisms with which we are here concerned may be secondary invaders in a virus disease or even dissociated meningococci.

The essential points differentiating these cases from typical meningococcic cases follow: In the fulminating cases the symptoms have been entirely cerebrospinal, while those of the meningococcic type were overshadowed by symptoms of septicemia. The tendency toward opisthotonos was slight, and in milder cases the patients were not so greatly prostrated. Even in the fulminating cases, the temperature was frequently normal. Except in the agonal stages and in patients having respiratory complications, it usually fluctuated between 98 and 102 F., while in our meningococcic cases it has usually been higher and more

5. Jaeger, H.: Zur Aetiologie der Meningitis cerebrospinalis epidemica, Ztschr. f. Hyg. u. Infectionskrankh. **19**:351, 1895.

septic in character. There have been no evidences of petechial hemorrhages; cutaneous lesions have been seen in only two cases, and in these they resembled those of chickenpox. Photophobia, when present, has been slight, and the infections of the upper respiratory tract that have usually preceded or accompanied these cases have been mild. The patients have only occasionally shown a tendency toward emaciation. In contrast to the frequent cases of deafness, ocular palsies, paralysis of limbs, ophthalmitis, pancarditis, etc., complications have been rare. There was one case with optic atrophy among the first sixty-eight; since then there have been two showing paralysis of one or both arms. The spinal fluid has been clear, the pressures extremely variable, the colloidal gold curves tabetic or dementia paralytic and the cellular reaction macrophagic. The meningococcus could not be isolated from the blood, spinal fluid or nasopharynx or at autopsy, and antimeningococcic serum has had a deleterious action in these cases. The gross pathology in the acute cases is not that of an inflammatory disease and, even in cases of from two to three weeks' duration, there is only slight gross evidence of a meningitis, and the vertex is most affected. The longer this epidemic has progressed, the greater have become the differences between these cases and those of uncomplicated meningococcic meningitis.

These cases can hardly have been atypical polioencephalitis because of: (1) the large number of severe cases without flaccid paralysis; (2) the absence of other typical cases of poliomyelitis in this vicinity; (3) the large number of adults attacked, and (4) the difference in the pathology.

Certain types of encephalitis might supposedly have fitted these cases, but, again, the pathologic findings revealed little inflammatory reaction in the brain; particularly, the basal ganglia were not involved, and hemorrhages within the brain were not seen. The microscopic changes resemble those described by Grinker and Stone [7] in acute toxic encephalitis. All their cases were secondary to some other infectious process. These patients did not show the mask or the tremors of epidemic encephalitis, and, after from four to six months, have not shown the sequelae. The term encephalitis, as frequently used, may cover more than one distinct clinical entity. The spinal fluid sugar early in the disease has been absent, lowered or normal, but has not been elevated as is frequently seen in epidemic encephalitis. Peroxidase-staining granules have been present, but the diagnostic value of this test is questionable.

If these were cases of tuberculous meningitis, there has been an epidemic in which about 60 per cent of the patients have recovered; this is certainly unlikely.

7. Grinker, R. R., and Stone, T. T.: Acute Toxic Encephalitis in Childhood, Arch. Neurol. & Psychiat. **20**:244 (Aug.) 1928.

In 1926, Wallgren [8] described acute aseptic serous or lymphocytic meningitis as a separate clinical entity; in 1929, Viets and Watts [9] reported five, and Krabbe [10] eleven cases. An acute onset with meningeal symptoms, meningitic changes in the spinal fluid, sterile spinal fluid and a short course without complications were the requirements of this entity. There have been numerous reports [11] since, and most of them emphasize the sterility of the spinal fluid. In 1930, Thorp [12] reported fifty-five atypical cases of cerebrospinal fever in about 50 per cent of which, after a diligent search of several specimens, an occasional diplococcus was seen. The organism was not described, and cultures were not mentioned. Krabbe,[10] Roch [13] and Eckstein [14] called attention to and emphasized the close relationship of such cases to poliomyelitis, encephalitis and influenza. Hoff [15] described eight cases of diplococcic encephalitis in 1931, and produced a similar disease in rabbits, but did not describe the organism.

The present epidemic did not follow or accompany one of poliomyelitis or of encephalitis, but paralleled and followed one of meningococcic meningitis. Recognized influenza did not appear in this vicinity until four months after several cases of this type had been seen, and these cases continued to appear after it had subsided. Serous meningitis is supposed to be rather mild and to be largely confined to children and young adults. The cellular reaction is reported as lymphocytic rather

8. Wallgren, A.: Eine eigenartige Form von epidemische Meningitis, Wien. Arch. f. inn. Med. **12**:297 (Feb.) 1926.

9. Viets, H. R., and Watts, J. W.: Aseptic (Lymphocytic) Meningitis, J. A. M. A. **93**:1553 (Nov. 16) 1929.

10. Krabbe, K. H.: Benign Lymphocytic Meningitis, Bibliot. f. læger **121**:511 (Nov.) 1929.

11. Roch, E. Martin, and Monedjikova, V.: La méningite aiguë lymphocytaire bénigne de nature indéterminée simulant la méningite tuberculeuse, Bull. et mém. Soc. méd. d. hôp. de Paris **54**:402 (March 24) 1930. Gunther, A.: Acute Aseptic Meningitis, Jahrb. f. Kinderh. **128**:127 (July) 1930. Gager, L. T.: Aseptic (Lymphocytic) Meningitis: Case Report, Virginia M. Monthly **57**:532 (Nov.) 1930. Gibbons, J.: Acute Aseptic Meningitis, Lancet **2**:12 (July 4) 1931. Velasco Blanco, L., and Bertrand, J. C.: Meningeal Condition Simulating Meningitis; Single Case, Arch. am. de med. **7**:122, 1931. Silberstein, J.: Benign Acute Lymphocytic Meningitis Simulating Tuberculous Meningitis, Semana méd. **2**:1194 (Oct. 15) 1931. Braithwaite, J. V. C., and Innes, W. M.: Epidemic Meningitis Minor, Brit. M. J. **2**:567 (Sept. 26) 1931. Lewy, F. H.: Serous Meningitis, Ztschr. f. klin. Med. **116**:38 (March) 1931.

12. Thorp, Eustace: Atypical Cerebrospinal Fever, Brit. M. J. **2**:731 (Nov. 1) 1930.

13. Roch, M.: Benign Lymphocytic Meningitis as Meningeal Form of Epidemic Encephalitis, Rev. méd. de la Suisse Rom. **51**:1 (Jan. 25) 1931.

14. Eckstein, A.: Epidemische Meningitis serosa, Ztschr. f. Kinderh. **50**:565 (Jan.) 1931.

15. Hoff, Hans: Diplococcus Encephalitis with Tumor-Like Symptoms, Ztschr. f. d. ges. Neurol. u. Psychiat. **134**:24, 1931.

than histiocytic and the spinal fluid is reported as sterile. The symptoms have not been those of an acute hydrocephalus as described by Quinke,[16] although an ependymitis was present in a few instances. The initial spinal fluid pressures have been almost as frequently normal or low as elevated, and the subsequent pressure readings have been high or low in the same patient. If classed as a meningitis, it is serous not lymphocytic, and not aseptic, but these cases might be described clinically and pathologically as an epidemic meningo-encephalopathy with a macrophagic and leukocytic reaction.

SUMMARY

1. Sixty-eight cases that do not conform to any of the described clinical entities are presented as an acute epidemic meningo-encephalopathy in which there is a macrophagic and leukocytic response.

2. An associated organism, with a few results of experiments on animals, is described.

3. One possible explanation for the failure of antimeningococcic serum as an adequate treatment in many cases, presumed to be due to the meningococcus alone, is suggested.

NOTE.—These cases are reported at this time chiefly in order to bring them to the attention of others who are working with meningococcic meningitis. More complete bacteriologic, hematologic and pathologic studies of these cases, which had reached a total of one hundred and thirty-five on April 25, 1932, are in progress.

16. Quinke: Deutsche Ztschr. f. Nervenh. **9**:149, 1896.

INFLUENCE OF VARIATIONS IN FLUID INTAKE ON INTRACRANIAL PRESSURE IN "EPILEPTICS"

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Cannon [1] has called attention to the "coordinated physiological reactions" that maintain the constancy or "homeostasis" of the organism. Much of our knowledge of physiology has come from study of the mechanisms by which "steady states" are maintained. Perhaps equally illuminating are the mechanisms by which homeostasis may be disturbed.

Cerebrospinal fluid pressure, i. e., hydrostatic pressure to which the central nervous system is exposed, is one of these "steady states." Weed and McKibben [2] found this pressure to be nearly constant at 119 mm. of spinal fluid in cats (ether anesthesia and basal conditions). In non-anesthetized healthy adult human beings we have found the pressure to be rarely outside the limits of from 80 to 180 mm. of spinal fluid (recumbent position and basal conditions).

In a series of articles [3] that have been published, one of us has shown that the osmotic and hydrostatic forces of the blood are the chief factors controlling the pressure of the cerebrospinal fluid. To these should be added cerebral vasoconstrictor and vasodilator influences, which may modify intracranial blood volume and hence intracranial pressure.

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1. Cannon, W. B.: Physiol. Rev. **9**:399, 1929.

2. Weed, L. H., and McKibben, P. S.: Am. J. Physiol. **48**:512, 1919.

3. Fremont-Smith, F.: The Nature of the Cerebrospinal Fluid, Arch. Neurol. & Psychiat. **17**:317 (March) 1927. Fremont-Smith, F., and Forbes, H. S.: Intra-Ocular and Intracranial Pressure: An Experimental Study, ibid. **18**:550 (Oct.) 1927. Forbes, H. S.; Fremont-Smith, F., and Wolff, H. G.: Resorption of Cerebrospinal Fluid Through the Choroid Plexus, ibid. **19**:73 (Jan.) 1928. Fremont-Smith, F., and Kubie, L. S.: The Intracranial Pressure in Health and Disease, Baltimore, Williams & Wilkins, 1929, chap. 7. Fremont-Smith, F.; Thomas, G. W.; Dailey, M. E., and Carroll, M. P.: Brain **54**:303, 1931.

The kidney is one of the most important regulators of the constancy of both the volume and the composition of the blood. One of us [4] has shown that when diuresis is normal, drinking water produces little change in the composition of the blood. When, however, diuresis is inhibited by the injection of posterior pituitary lobe extract (pitressin), a well marked dilution of the blood serum occurs. From these experiments it might be inferred that drinking water would produce but little effect on the cerebrospinal fluid pressure as long as diuresis is normal, but that with diuresis inhibited, drinking water would result in a rise in cerebrospinal fluid pressure secondary to the fall in osmotic pressure of the blood.

It is our purpose in this paper to report such data, contrasting in acute experiments the influence of drinking water on intracranial pressure when diuresis is normal with the results that occur when diuresis is inhibited, and, to demonstrate the effect on intracranial pressure of forcing fluids over a period of five days as compared with the effect of restricting fluids over a similar period. These studies were made on patients suffering from repeated generalized convulsions.

METHODS AND RESULTS

Measurements of the cerebrospinal fluid pressure were made in a quiet room under basal conditions with the patient in a recumbent lateral position. A spirit level was used to insure a true horizontal position of the patient, the level of the lumbar spine and the external occipital protruberance being maintained at an equal elevation. The lumbar punctures were done under procaine hydrochloride anesthesia without epinephrine. The Fremont-Smith modification of the Ayer spinal puncture needle and manometer were used. The pressure readings, expressed in millimeters of spinal fluid, have been corrected for the capillarity of the manometer.

The question has been raised as to the relative accurracy of "water" and mercury manometers for the measurement of cerebrospinal fluid pressure. The "water" manometer has a certain error due to capillarity dependent on the bore of the manometer. The capillarity of the water manometer used in these experiments was 15 mm. Our data have been corrected for this amount. As suggested by Weed, Flexner and Clark,[5] however, it is doubtful whether full effect of capillarity obtains when the column of fluid is constantly oscillating.

In one patient a Fleischer mercury manometer was attached to an 18 gage needle in the space between the fourth and fifth lumbar vertebrae, while the water manometer was attached to an 18 gage needle in the space between the third and fourth lumbar vertebrae. Two observers, one for each manometer, recorded the pressures simultaneously each minute for a period of thirty minutes. The average pressures for ten minute periods are presented in table 1. It will be seen that when the "water" manometer pressure is uncorrected, it averages 8 mm. of spinal

4. Fremont-Smith, F.; Putnam, T. J., and Cobb, S.: Forced Drainage of the Central Nervous System, Arch. Neurol. & Psychiat. **23**:219 (Feb.) 1930.

5. Weed, L. H.; Flexner, L. B., and Clark, J. H.: Am. J. Physiol. **100**:246, 1932.

fluid higher than the mercury manometer, but when corrected by the subtraction of 15 mm. for the capillarity previously determined, the "water" manometer pressure averages 7 mm. of spinal fluid lower than the mercury manometer pressure. From this experiment it may be concluded that: (1) the effect of capillarity is diminished by the constant movement of the column of fluid due to pulse and respiratory oscillations, and (2) the difference between the pressures recorded by mercury and by "water" manometers is negligible, whether the "water" manometer readings are corrected for capillarity or not. Moreover, such factors as the position of the patient, the character of the breathing and the degree of relaxation introduce errors of far greater magnitude. The "water" manometer has the advantage that it is more sensitive to slight or rapid changes in pressure and is therefore of greater value in testing the dynamics of the ventriculosubarachnoid system.

TABLE 1.—*Comparison of the Cerebrospinal Fluid Pressures Obtained by Use of Mercury Manometer and "Water" Manometer (Double Puncture)*

	Average Reading of Mercury Manometer		Average Reading of Water Manometer	
Period of Observation	Mm. Hg	Mm. C.S.F.	Observed Mm. C.S.F.	Corrected for Capillarity Mm. C.S.F.
First 10 minutes	13.5	183	186	171
Second 10 minutes	13.1	178	195	180
Third 10 minutes	13.4	182	186	171
Average	13.3	181	189	174

* This table shows that the observed spinal fluid pressure with the water manometer averages only 8 mm. of spinal fluid higher than the observed pressure with the mercury manometer. When 15 mm. is subtracted from the observed water manometer pressure to correct for capillarity, the pressure averages 7 mm. lower than the observed pressure with the mercury manometer. Whether corrected for capillarity or not, the water manometer pressure agrees with the mercury manometer pressure within the limits of error of this clinical measurement, i. e., within 8 mm. of spinal fluid or within 0.6 mm. of mercury.

During all of the experiments the pressure was observed continuously, and for each period of one minute the highest and lowest pressures were recorded. The pressure readings were averaged for ten or thirty minute periods for use in the tables and figures. At the beginning and again at the end of each experiment jugular compression produced a prompt and adequate rise in spinal fluid pressure, thus demonstrating that the needle was in position, that the needle and manometer were patent and that the pressures recorded truly represented the pressures within the ventriculosubarachnoid system. At the beginning of each experiment the pressure was recorded for at least thirty minutes in order to obtain an accurate base line. Since any movement on the part of the patient or tension resulting from discomfort tends to raise intracranial pressure, it was of utmost importance to have the patients comfortable and relaxed throughout these prolonged experiments. This was accomplished by a suitable arrangement of pillows. After each experiment fluid was removed for cytologic and chemical study.

The experiments were divided into two groups: (1) to determine the effect on the cerebrospinal fluid pressure of the rapid drinking of a large amount of water; (2) to determine the effect of five day periods of high water intake and of low water intake on the cerebrospinal fluid pressure.

In the first group of experiments ten patients were given from 1 to 2.5 liters of water to drink during a period of from forty to sixty minutes (one patient received 200 cc. of water every half hour to a total of 1 liter). Table 2 summarizes the results in these cases. A review of this table shows that the rapid drinking of this amount of water had no appreciable effect on the cerebrospinal fluid pressure over a period of observation of from two and one-half to three and one-half hours,

TABLE 2.—*The Effect of Drinking Water on the Cerebrospinal Fluid Pressure* *

	Case										Aver-age
	1	2	3	4	5	6	11	13	14	15	
	Cerebrospinal Fluid Pressure (Mm. C.S.F.)										
Control period (30 min.)	118	171	124	75	228	166	138	64	157	133	126
Period of drinking.....	129	151	125	85	209	134	149	73	195	145	132
After drinking water											
First 30 minutes.....	125	173	112	78	215	146	168	68	221	145	137
Second 30 minutes.....	100	179	112	85	...	124	148	65	229	120	129
Third 30 minutes.....	100	160	110	78	...	133	146	60	202		
Fourth 30 minutes.....	102	179	...	55							
Water intake (cc.).....	1,000	1,000	2,500	2,500	1,250	2,000	1,000	1,500	1,750	2,200	1,670
Urine output (cc.).....	1,120	1,035	2,300	1,910	1,200	1,635	925	1,285	1,425	1,485	1,432

* Case 5 not used in computing averages.

TABLE 3.—*The Effect of Pitressin and Drinking Water on the Cerebrospinal Fluid Pressure*

	Case							Average
	1	2	3	4	5	6	12	
	Cerebrospinal Fluid Pressure (Mm. C.S.F.)							
Control period (30 min.).....	135	207	115	40	239	133	117	141
Period of drinking.....	128	210	151	73	196	159	136	150
After drinking water								
First 30 minutes.....	149	233	161	132	273	217	184	193
Second 30 minutes.....	167	232	165	136	343	183	195	203
Third 30 minutes.....	162	225	147	*	...	158		
Fourth 30 minutes.....	...	225	130	...	...	*		
Water intake (cc.).....	1,000	1,000	2,200	2,200	1,450	2,000	2,200	1,580
Urine output (cc.).....	200	0	220	180	350	177	100	175

* Indicates convulsion.

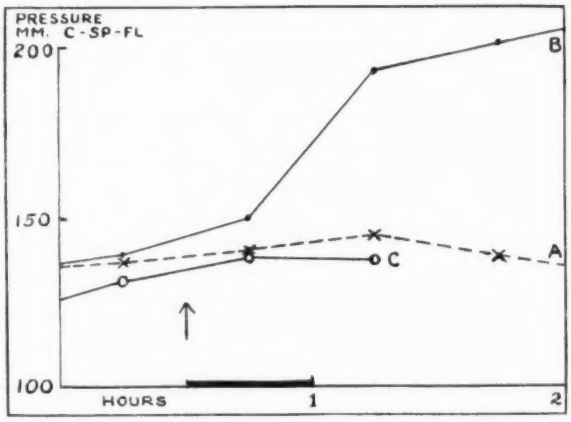
except in one instance (case 14) in which the patient became restless during the test. In all other cases the cerebrospinal fluid pressure showed practically no change during the period of the experiment. It should be noted also that these patients had excreted over 85 per cent of the ingested water by the end of the test. It is reasonable to assume that the duration of the experiments was sufficient to manifest any effect of the ingested water on the cerebrospinal fluid pressure.

Seven patients were given water to drink in the same manner as in the preceding ten cases, but they were prevented from excreting the

water by the intramuscular injection of 0.5 cc. of a solution containing the antidiuretic principle of the pituitary gland (pitressin). In these cases, as shown in table 3, there was a definite rise in intracranial pressure, averaging 63 mm. of cerebrospinal fluid (an average increase of 44 per cent over the control pressure). These patients excreted only 11 per cent of the ingested fluid during the period of the test.

TABLE 4.—*The Effect of Pitressin on the Cerebrospinal Fluid Pressure*

	Case 1	Case 2	Case 4	Average
	Cerebrospinal Fluid Pressure (Mm. C.S.F.)			
Control period	116	107	134	119
First 30 minutes after pitressin	125	105	143	124
Second 30 minutes after pitressin	138	100	122	120



The effect of the rapid ingestion of a large amount of water on the cerebrospinal fluid pressure. *A*, average of the cerebrospinal fluid pressures in ten cases, showing the effect of the rapid ingestion of a large amount of water. (Average intake, 1,670 cc. Average urinary output, 1,432 cc.) *B*, average of the cerebrospinal fluid pressure in seven cases, showing the effect of the rapid ingestion of a large amount of water when diuresis is inhibited. (Average intake, 1,580 cc. Average output, 175 cc.) *C*, average of the cerebrospinal fluid pressures in three cases to show the effect of injection of 0.5 cc. of pitressin. No water was ingested. The arrow indicates the end of the control period. The heavy black line indicates the period of drinking water.

To determine whether this increase in intracranial pressure was due to the pitressin itself, three patients were given the same dose of pitressin without the ingestion of water. As is shown in table 4, there resulted no significant rise in the pressure for a period of one hour after the injection of the pitressin.

These experiments show that the rapid ingestion of water in amounts up to 2.5 liters has no effect on cerebrospinal fluid pressure, provided

the diuresis is normal. When, however, diuresis is inhibited, a rise in pressure occurs. This is graphically demonstrated in the accompanying chart.

The second group of experiments was performed in order to determine whether a prolonged period of high fluid intake would produce an elevation of cerebrospinal fluid pressure, and whether a period of marked fluid restriction would lower the pressure.

The cerebrospinal fluid pressure was determined after a period of at least five days of normal fluid intake,[6] to serve as a control. Then, after a five day period of high fluid intake (from 4 to 6 liters per

TABLE 5.—*High Fluid Intake for Five Days*

Patient	Average Daily Fluid Intake, Liters	Average Daily Fluid Output, Cc.
1	4 - 5	4,000
2	4 - 5	3,100
3*	4 - 5	
6	5 - 6	4,100
7	5 - 6	4,600
8	5 - 6	5,400
9	5 - 6	

* Lumbar puncture was done after thirty-six hours, and the test was discontinued on account of two severe convulsions and persistent headache. The pressure was low (65 mm. of cerebrospinal fluid).

TABLE 6.—*Low Fluid Intake for Five Days*

Patient	Average Daily Fluid Intake, Cc.	Average Daily Urine Output, Cc.
1	100	830
2	100	730
5	350	592
6	300	
7	200	480
8	200	505
9	100	320
Average	200	576

twenty-four hours), and again after a five day period of fluid restriction (from 100 to 350 cc. in twenty-four hours), the cerebrospinal fluid pressure was measured. The results are presented in tables 5, 6 and 7.

Seven patients were given from 4,000 to 6,000 cc. of fluid daily in addition to the fluid contained in their foods. As is shown in table 5, the diuretic response was satisfactory in all the cases, as the urinary output averaged over 4,000 cc. daily. There was no consistent change in the patients' weights in the four instances in which the patients were weighed daily. The most marked changes were a decrease of 2.3 Kg. in case 2 and an increase of 1.9 Kg. in case 6.

6. By normal fluid intake it is meant that the patients were given the regular ward diet and were allowed to take fluids as desired. It is intended to represent the average or usual fluid intake of the patient.

In seven cases the fluid intake, exclusive of the water in the foods, was limited to from 100 to 350 cc. per day. The procedure followed was to allow no fluids for the first two or three days of the procedure and to allow on the last two days a maximum of 400 cc. per day. Foods with a high water content, such as fruits, were eliminated so far as possible, but no attempt was made to give the patients a strictly dry diet. The degree of fluid restriction is indicated by the fact that the daily urinary output of these patients, as shown in table 6, averaged 576 cc. There was no constant variation in the patients' weights in the three instances in which the patients were weighed daily. The most marked changes were a gain of 1.5 Kg. in case 2 and a loss of 0.8 Kg. in case 8.[7]

TABLE 7.—*Comparison of the Cerebrospinal Fluid Pressure After Period of Normal Fluid Intake with the Pressure After Five Day Periods of Low Fluid Intake and High Fluid Intake, Respectively*

	Cerebrospinal Fluid Pressure (Mm. C.S.F.)		
Case	Normal Fluid Intake	Low Fluid Intake	High Fluid Intake
1	121	134	120
2	175	188	173
3*	125	...	65
5*	228	244	...
6	149	174	167
7	115	76	62
8	156	152	132
9	131	132	117
Average	141	143	128

* Not included in the average.

7. Since this paper was presented we have placed one patient (a male, aged 21) on rigid fluid restriction. For six days this patient received a "dry diet" and no fluids, excepting one orange each day and cracked ice, totalling less than 1 ounce (30 cc.) for the six days. During this period the average urinary output was 600 cc. per day, with an average specific gravity of 1.031. There were a loss of 5.5 Kg. in body weight and a concentration of the blood serum, including a rise in nonprotein nitrogen from 35 to 50 mg. per hundred cubic centimeters. In the control period, before fluid restriction, the spinal fluid pressure was 169 mm. of cerebrospinal fluid (average value for the third ten minutes of the thirty minute period), and 158 mm. at the end of the six day period of fluid restriction. Fluids were then forced for seven days. For the last six of these days the average urinary output was 4,690 cc. per day, with an average specific gravity of 1.003. During the last twenty-four hours, the urinary output was 6,800 cc., with a specific gravity of 1.001. There were a gain of 3.8 Kg. in body weight and a return of the blood serum to its normal concentration. The spinal fluid pressure (average value for the third ten minutes of a thirty minute period) was 174 mm. of cerebrospinal fluid. Thus, a period of rigid fluid restriction resulted in a lowering of spinal fluid pressure from 169 to 158 mm. of cerebrospinal fluid, while a period of forcing fluids raised the pressure to 174 mm. These slight variations in pressure are hardly outside the limits of error of this clinical measurement.

Table 7 shows the cerebrospinal fluid pressure after the periods of high fluid intake and low fluid intake as compared with the pressure after a period of normal fluid intake. From this table it can be seen that such variations in the level of fluid intake have little if any effect on the cerebrospinal fluid pressure. In fact, the average pressure after a period of low fluid intake was almost exactly the same as after a period of "normal" intake. It is of interest that the cerebrospinal fluid pressure after the period of high fluid intake averaged 13 mm. *lower* than after the period of "normal" or usual intake. It is evident that forcing fluids in these patients caused no increase in cerebrospinal fluid pressure, and that restricting fluids failed to lower the pressure.

It is also significant that the variation in the level of fluid intake had no appreciable effect on the amount of cerebrospinal fluid in the ventricles and subarachnoid space as determined by the method of Ayala.[8] Ayala's method of determining the cerebrospinal fluid reservoir is based

TABLE 8.—*Comparison of Cerebrospinal Fluid Pressure Before and After the Removal of 15 cc. of Cerebrospinal Fluid in the Experiments with Low and High Fluid Intake*

	Low Fluid Intake			High Fluid Intake		
	Pressure			Pressure		
Case	Initial	Final	Ayala's Index	Initial	Final	Ayala's Index
1	134	50	5.6	120	55	6.8
2	188	85	6.8	173	80	6.9
6	174	80	6.9	167	100	8.9
7	76	45	8.8	62	35	8.5
8*	152	103	6.8	132	95	7.2
9	132	63	7.1	117	43	5.5
Average			7.0			7.2

* Only 10 cc. of cerebrospinal fluid removed.

on the rate of fall in pressure on removing fluid. Ayala's index is obtained by dividing the product of the final pressure multiplied by the number of cubic centimeters removed by the initial pressure. Table 8 shows that, although there was some variation in Ayala's index in the individual cases, this variation was not consistently in one direction. The index averaged 7.0 and 7.2 for the six cases after the periods of low fluid intake and high fluid intake, respectively. This would indicate that the level of fluid intake, within the limits of these experiments, had no appreciable effect on the cerebrospinal fluid reservoir.

THE EFFECT OF WATER INTAKE ON THE INCIDENCE OF CONVULSIVE SEIZURES

Although this work was not undertaken primarily to determine the relationship of the level of water intake to the incidence of convulsive seizures, some interesting findings in this regard were obtained.

8. Ayala, G.: Ztschr. f. d. ges. Neurol. u. Psychiat. **84**:42, 1923.

In the first group of experiments, a convulsion occurred in case 1 about eight hours after the patient drank a liter of water. In case 4 there was a seizure about one-half hour and another about three hours after completion of the experiment, during which the patient drank 2,200 cc. of water and diuresis had been inhibited by pitressin. In case 6 there occurred a seizure about fifteen minutes after the completion of a similar experiment in which 2,000 cc. of water was ingested. The convulsions in the latter two cases, which occurred within one-half hour after the completion of the experiment, were of especial interest in that cerebrospinal fluid had just been removed and the patients were, therefore, left with a low intracranial pressure (70 and 75 mm., respectively) and with an undistended subarachnoid space.

In the second group of experiments, six of the seven patients had convulsions during a period of high fluid intake, although the cerebrospinal fluid pressure was not found to be elevated at the end of the period. In case 2 the patient had thirteen convulsions during the five days of high fluid intake, and in case 3 the experiment had to be discontinued at the end of thirty-six hours on account of two convulsions and severe headache. Lumbar puncture at this time showed a pressure of only 65 mm. of cerebrospinal fluid. On the other hand, only two of seven patients had convulsions during the period of low fluid intake. In case 2 the patient had three convulsions during this period (as against thirteen during the period of high fluid intake), and in case 7 had one convulsion (as against five during the period of high fluid intake). It is also interesting to note that the patient in case 7 was not receiving phenobarbital during the period of low fluid intake, but had been receiving 1½ grains (0.097 Gm.) per day during the period of high fluid intake. This was the only patient who received any sedative during the period of the experiments.

TABLE 9.—*The Incidence of Convulsive Seizures with Relation to the Level of Fluid Intake*

Case	Average Interval Between Attacks	Number of Attacks	
		High Fluid Intake, 5 Days	Low Fluid Intake, 5 Days
1	2 weeks	1	0
2	2 days	13	3
5	3 weeks	2*	..
6	1 week	1	0
7	1 month	5	1
8	1 month	1	0
9	3 weeks	0	0
Total attacks		23	4

* The test was discontinued after thirty-six hours on account of convulsions and headache. Lumbar puncture at this time showed a low pressure (65 mm. of cerebrospinal fluid).

Table 9 summarizes the incidence of convulsions during these experiments.

COMMENT

The data here presented clearly indicate that the ingestion of large amounts of water in acute and in prolonged experiments causes no rise in cerebrospinal fluid pressure. Moreover, the restriction of fluid intake within the limits here employed causes no decrease in this pressure. The diuretic response of the kidneys is so prompt and adequate that the internal environment of the organism is practically undisturbed by this rapid fluid turnover, whereas when the fluid intake is restricted (within the limits of our experiments), the kidneys conserve fluid, thus maintaining "homeostasis," or the constancy of the internal environment.

When the diuretic function of the kidney is inhibited, homeostasis is disturbed. The ingestion of water then produces a marked dilution and fall in osmotic pressure of the blood plasma.[4] This results in an increased rate of formation and a decreased rate of absorption of cerebrospinal fluid, which explains the increase in cerebrospinal fluid pressure which we are here reporting. This mechanism was first demonstrated by Weed and McKibben,[2] who injected distilled water intravenously into cats and thus produced an increase in the cerebrospinal fluid pressure.

Our data show that not only is the cerebrospinal fluid pressure practically unaffected by marked variations in the level of fluid intake, but the volume of the cerebrospinal fluid reservoir as measured by Ayala's index is not materially influenced by such variations in the fluid intake. As is shown in table 8, we had no difficulty in obtaining 15 cc. of cerebrospinal fluid at the end of the five day period of fluid restriction without unduly lowering the pressure.

Our data in a small series of patients are in accordance with the findings of McQuarrie[9] and of Fay,[10] that restricting fluids tends to diminish the number of convulsions and that increasing the level of fluid intake may increase the number of seizures in some patients. It is evident, however, that whatever influence the level of fluid intake has on the incidence of convulsive seizures, this influence is not brought about through variations in cerebrospinal fluid pressure.

SUMMARY

The data in this paper demonstrate that:

1. The ingestion of from 1 to 2 liters of water causes no appreciable effect on the cerebrospinal fluid pressure in patients suffering from convulsions provided water diuresis is normal.

9. McQuarrie, I.: Epilepsy in Children: The Relationship of Water Balance to the Occurrence of Seizures, Am. J. Dis. Child. **38**:451 (Sept.) 1929.

10. Fay, T.: J. Nerv. & Ment. Dis. **71**:481, 1930.

2. When water diuresis is inhibited by an injection of the antidiuretic principle of the pituitary gland (pitressin), a definite rise in the cerebrospinal fluid pressure takes place.

3. Pitressin alone without the ingestion of water causes little, if any, rise in cerebrospinal fluid pressure.

4. Variations in the level of fluid intake (exclusive of that obtained in solid foods) from 200 cc. or less per day for a five day period to from 4 to 7 liters per day for a similar period produces no appreciable change in intracranial pressure or cerebrospinal fluid volume.

CONCLUSIONS

1. Well marked variations in the level of fluid intake in man have no appreciable effect on the pressure of the cerebrospinal fluid.

2. The influence of the level of fluid intake on the incidence of convulsive seizures is not dependent on variations in intracranial pressure.

ABSTRACT OF DISCUSSION

DR. TEMPLE FAY, Philadelphia: Five years ago we presented the theory and method of dehydration and pointed out its value in the control of certain types of the major convulsive seizure. Subsequent work indicated that a proper fluid balance as well as a modified diet, so as to maintain a state of dehydration, proved to be successful in the management of the major convulsive seizure.

The time allotted for this discussion is too brief to take up the details surrounding the problem of dehydration. I wish to present a few slides, analyzing the data presented by Dr. Fremont-Smith and Dr. Merritt to illustrate important considerations of this problem.

The results that they have presented are based on epileptic patients who had been placed first on a high level of fluid intake for a period of five days and subsequently on a low level of fluid intake for a similar period. The readings of the intracranial pressure showed no appreciable change in pressure occasioned by the high or the low period of ingestion of fluid. The weight of the patient is an important consideration in determining whether or not fluid has been eliminated or retained by the body, and with the intake and output known, the question can be mathematically determined as to whether or not the limitation of fluid has been effectual in producing dehydration by the loss of body fluid and a consequent loss in weight, or whether retention of fluid has occurred, with a consequent increase in body weight.

The patient in case 1 received 100 cc. of fluid daily, or a total of 500 cc. for five days. The urinary output was approximately 4,500 cc. The amount lost by the skin, breath and bowels is, of course, not determinable. In this case there was no appreciable change in weight. As a pint weighs approximately 1 pound (453.6 Gm.), it is evident that the patient received 1 pound of fluid, passed 8½ pounds (3,855.5 Gm.) of urine and lost an indefinite amount through the skin, breath and bowels, but showed no change in body weight. It is evident that the patient must have received fluid from some other source, and as the diet was not controlled, the extra fluid must have entered through the food, because at least 7½ pounds (3,401.9 Gm.) of fluid produced, and possibly much more when all factors are considered, are unaccounted for.

In order to produce dehydration, not only strict control of the intake of liquid but a measured amount of fluid in the diet must be administered so that stored tissue fluids will be eliminated to take care of the body requirements. In another case which they observed, the patient received 500 cc. or approximately 1 pound of fluid in the five days of study, eliminated more than 3,500 cc. of urine, or approximately 7¾ pounds (3,512.8 Gm.), and besides gained 3 pounds (1.4 Kg.) in body weight, thus clearly indicating that the source of additional fluid and weight must have been because of the failure to control the dietary factor. In case 8 the patient lost ¾ pound (0.3 Kg.) of weight when fluids were forced for five days. In fact, in their entire series of limiting and of forcing fluids, there was no appreciable change in weight except in cases 2 and 6.

It is evident that the storage reservoirs of the body were not affected, and hence one would not expect a rise or fall in intracranial pressure, as renal function adequately compensated for the addition or subtraction of fluid without disturbing the water metabolism of the body. In their experiments with pitressin, however, the intake of fluid was greatly in excess of the output because of the suppression effect on the kidneys caused by the pitressin. Although the weights were not recorded in this series, it is significant to note the great discrepancy between intake and output and the evident storage of fluid because of failure of renal elimination, and, as one would expect, the intracranial pressure rose 44 per cent in this series.

It is interesting that only four convulsive seizures were noted during the period of low fluid intake, and that during the period when fluids were forced, twenty-one convulsions occurred in the same group covering a similar period of time.

When the presenters rapidly forced fluids on their patients, you will note that the intake and output were practically balanced. In other words, no retention of tissue fluids occurred, and therefore, as might be expected, no change of intracranial pressure was recorded as there had been no apparent accumulation in the subarachnoid fluid reservoir.

In contrast to this series of cases I am presenting a similar series in which actual dehydration has been accomplished by control of both the intake of liquid and the diet consumption. It will be noted that there is a progressive loss of body weight recorded in this group. These patients did not receive hypertonic salt solution or any other dehydrating agent. The fluid reservoirs were depleted because of insufficient ingestion. It is noteworthy to see the rapid fall in cerebrospinal fluid pressure which occurred from day to day in each member of this group. I believe, as the authors have stated, that we find agreement in all but one point, and that is the importance of cerebrospinal fluid pressures in relation to the ratios of intracranial volume components.

I believe that small changes of pressure occur only after compensatory shift of blood volume has reached its limit of passive activity. We agreed to disagree on the question of what constitutes a normal intracranial pressure reading. I accept from 6 to 10 mm. of mercury as being within the range of normal and 8 mm. of mercury as being the average. Translated into terms of their water manometer readings of normal (from 100 to 200 mm. of water), this would mean from 7 to 13.5 mm. of mercury pressure. I think that the pressure of 13.5 mm. of mercury which Fremont-Smith accepts as "top-normal" is actually, in my experience, a definitely increased intracranial pressure. This matter, I believe, will be the subject of another paper, and I trust we may approach some common standard of agreement between the values accepted for mercury and those accepted now for water manometer readings.

The following slides indicate our analysis of intracranial pressure in one hundred epileptic patients as compared with spinal pressure readings in cases of tumor of

the brain and in cases of miscellaneous organic neurologic diseases. As noted, the brain tumor group averages 16 mm. of mercury; the epileptic group, 10.5 mm. of mercury, whereas the normal and miscellaneous neurologic group averages 8 and 9 mm. of mercury. Thus, I am convinced that the "top-normal" values include as "normal" what I would consider definitely increased spinal fluid pressure readings, and what they consider "normal" I have maintained was evidence of a "definite increase in intracranial pressure."

I am still convinced that the dehydration therapy, presented five years ago, actually produces a decrease in cerebrospinal fluid pressure when properly maintained, and that the regulation of fluid intake can be accomplished only when all factors, including the diet, are carefully controlled.

I should like to ask the authors whether, in their opinion, had their patients been strictly controlled and actually dehydrated, would they not have expected a fall in spinal fluid pressure instead of no change, as their present findings indicate.

DR. FREMONT-SMITH, Boston: In answer to Dr. Fay's question, we agree with him that if the patients are sufficiently dehydrated, a lowering of the spinal fluid pressure will result. How much loss of fluid is necessary to effect this probably depends on the rate and manner of fluid substraction. For instance, the rapid withdrawal of a given volume of fluid by the ingestion of concentrated magnesium sulphate solution would be expected to lower the spinal fluid pressure more than would an equivalent but more gradual loss of fluid through the skin and kidneys (dependent on an inadequate intake of fluid). When the loss of fluid is gradual, I should expect the spinal fluid reservoir to be one of the last to be depleted.

The point that we should like to make in this paper is that when the level of fluid intake was varied within the limits that we used, there was no appreciable effect on the spinal fluid pressure. We do not doubt that the degree of fluid restriction employed by Dr. Fay is more rigid than that to which our patients were subjected.

In the cases Dr. Fay showed on the slides the patients had daily punctures during the period of fluid restriction, and a progressive fall in pressure occurred. When daily punctures are performed, even when no fluid is withdrawn, it is possible to have a leakage from the needle hole in the dura into the epidural space, and even into the tissues of the back, which could cause a progressive lowering in pressure. This is the mechanism of headache caused by lumbar puncture, and, I suspect it may account for some of the low pressures and "dry taps" which he reported.

Before such low pressures may be accepted as being due to a limitation of fluid, this factor of leakage from previous punctures should be controlled. Once the spinal fluid pressure has been lowered, as by lumbar puncture, strict limitation of fluid should delay the return of the pressure to the original level.

I should like to call attention to what I think is perhaps the most interesting phase of this work. The fact that the intracranial pressure did not change as a result of these marked variations in the level of fluid intake is an illustration of what Dr. Cannon calls homeostasis, or the ability of the body to maintain a steady state. When the diuresis is inhibited by pitressin, we see a disturbance in homeostasis resulting in a rise in cerebrospinal fluid pressure.

ACALCULIA (HENSCHEN)

A CLINICAL STUDY

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AND
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Acalculia is an inability to perform simple arithmetic operations; it may occur either as a concomitant symptom within an aphasic syndrome or as the main or even the only symptom of a focal cerebral lesion. As a concomitant symptom it is probably associated with many of the common aphasias. Henschen [1] was able to collect from the literature no less than 260 cases in which acalculia was mentioned as an accompanying condition. That in many more cases it had been present but was overlooked appears to be a safe assumption.

Cases in which acalculia was the outstanding or exclusive symptom of a cerebral lesion have been described by Lewandowsky and Stadelmann,[2] Peritz,[3] Sittig,[4] Berger,[5] Gerstmann,[6] Herrmann [7] and Lange.[8] The views expressed in these publications on the nature of the condition are sufficiently controversial and obscure to warrant the addition of a new case to the list of those already published.

REPORT OF A CASE

Clinical History.—A white man, aged 44, an assistant superintendent of a firm of boiler and water tank engineers, was admitted to the Edward Hines, Jr.,

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Read at the Fifty-Eighth Annual Meeting of the American Neurological Association, Atlantic City, N. J., June 7, 1932.

1. Henschen, S. E.: Klinische und anatomische Beiträge zur Pathologie des Gehirns, Stockholm, 1920, pt. 5.

2. Lewandowsky, M., and Stadelmann, E.: Ueber einen bemerkenswerten Fall von Hirnblutung und über Rechenstörungen bei Herderkrankung des Gehirns, J. f. Psychol. u. Neurol. **11**:249, 1908.

3. Peritz, G.: Zur Psychopathologie des Rechnens, Deutsche Ztschr. f. Nervenh. **61**:234, 1918.

4. Sittig, O.: Störungen des Ziffernschreibens und Rechnens bei einem Hirnverletzten, Monatschr. f. Psychiat. u. Neurol. **49**:299, 1921.

5. Berger, H.: Ueber Rechenstörungen bei Herderkrankungen des Grosshirns, Arch. f. Psychiat. **78**:238, 1926.

6. Gerstmann, J.: Fingeragnosie und isolierte Agraphie, ein neues Syndrom, Ztschr. f. d. ges. Neurol. u. Psychiat. **108**:152, 1927.

7. Herrmann, G.: Beiträge zur Lehre von den Störungen des Rechnens bei Herderkrankungen des Okzipitallappens (Akalkulie Henschen), Monatschr. f. Psychiat. u. Neurol. **70**:193, 1928.

8. Lange, J.: Fingeragnosie und Agraphie, Monatschr. f. Psychiat. u. Neurol. **76**:129, 1930.

Memorial Hospital on Oct. 3, 1930, with the tentative diagnosis of a "traumatic psychosis." The family history was without significance. The patient had had no previous illnesses. He had attended school to the age of 11, when he went to work, but he had attended night school until the age of 16. He had been employed for a number of years as an assistant superintendent by a responsible firm, and at times had fifty men working under him. His work required that he estimate the cost of jobs and keep track of time and the wages of the men under him. His employers speak of his work in the highest terms. He served in the Navy during the World War, and had since been employed steadily.

On Feb. 10, 1930, he drove into his garage, and, shortly afterward, was found unconscious on the floor. The neighbors who found him reconstructed the story as follows: He had driven into the garage and raised the hood of the car to make an inspection. The door of the garage blew closed. He slipped and in doing so struck the accelerator, set the motor racing and became asphyxiated. He was taken to the Auburn Park Hospital. A blood count, made on February 13, showed 4,880,000 red cells, 17,200 white cells and 95 per cent hemoglobin. No other laboratory tests were made. On February 13 and 14, "his condition was much improved although he was unable to see" This is not quite in accord with the condition reported on February 14.

On February 14, he was admitted to the Wesley Memorial Hospital, where he regained consciousness after two days. "However, he suffered from total loss of vision for the following three weeks," and had frequent crying spells. On March 11, he returned home, and it was noted that when he started to talk on a subject he harped on it for a long time. He had lost his memory "for practically everything."

When admitted to the Edward Hines Hospital it was noted that he was unable to dress himself and would put the left leg into the right leg of his trousers. He was equally awkward in attempts to put on his coat or shirt, and had to be assisted in these acts. He complained that everything seemed "left-sided" with him. For example, his bed sheet was rumpled and needed straightening on the right edge of the bed; no matter how often he attempted to pull it to the right, he always pulled to the left. In writing numbers he reversed the position of the digits. Memory for remote events was said not to be disturbed. In performance tests he was apraxic. He could tell the position of the hands of a clock but could not indicate the time. He was able to recognize tools and their use, but was unable to handle them; e.g., he knew a hammer and a nail, but he could not drive a nail.

A physical examination, made on October 3, gave completely negative results as to the cranial nerves, reflexes, motility, sensibility, coordination, gait and the Romberg test. Vision was 20/30 in the right eye and 20/20 in the left eye. The fundi were normal. Repeated tests demonstrated that no hemianopia was present. The range of hearing was 12 feet (365.7 cm.) with the right ear and 10 feet (304.8 cm.) with the left ear for the conversational voice; for the whispered voice, it was 5 feet (152.4 cm.) with the right ear and 3 feet (91.4 cm.) with the left ear.

Laboratory Tests: The urine was normal; the Wassermann and Kahn reactions of the blood were negative. A blood count showed: 4,000,000 red cells and 10,000 white cells, of which 68 per cent were polymorphonuclears, 20 per cent small mononuclears, 8 per cent large mononuclears, 2 per cent eosinophils and 2 per cent transitional cells; the hemoglobin was 80 per cent; the color index was 1. The spinal fluid showed a pressure of 30; the globulin and cell content were normal; the Wassermann reaction was negative; the Lange gold curve was 00011100000.

A diagnosis of encephalitis due to carbon monoxide poisoning was made.

Examination for Aphasia.—On October 29, a special examination was made for aphasic symptoms by the method described by the junior author.[9] It was found that the patient had some slight difficulty at times in finding words, but he was able to name objects shown to him, to indicate objects named verbally or in print and to designate the use of objects. He was able to repeat sense and nonsense words and sentences of considerable length and complexity. Reading was good for both sense and nonsense material, and for letters, syllables, words, sentences and paragraphs. The only mistakes that he made in reading referred to the pairs of letters p and q and b and d, which were often confounded when they were offered as isolated letters. In their context within a word, sentence or paragraph, these letters were never exchanged for each other.

In tests for eupraxis, the patient was well able to imitate even complex movements and to carry out complex orders of various kinds, but he was unable to carry out a total act the parts of which involved a continuous change in spatial arrangement, such as tying a knot or wrapping a book and tying a string crosswise around it.

The main defects lay in the sphere of arithmetic and writing. In these he proved well nigh helpless. Writing, whether spontaneous, dictated or copied, was reduced to a hardly legible scribble. So far as it could be deciphered, it suggested that the patient wrote mainly in response to auditory stimuli. The words were written as they were spoken, phonetically: Lincoln was spelled Lincelen, and captain, capten. In calculation he proved completely defective. Even the simplest operation, like 5 plus 6, could not be done.

Since acalculia and agraphia have been shown by Gerstmann[6] to be frequently associated with chromagnosia (inability to recognize colors) and with finger agnosia (inability to manipulate, recognize, indicate and name the individual fingers), color perception and finger manipulation were carefully tested. The patient showed great facility in sorting and naming colors. He was even able to arrange the various color shades of the hemoglobin scale after some initial mistakes. He manipulated his fingers rather clumsily, but was able to name, indicate and show them correctly on request after some initial mistakes and subsequent instruction. However, he volunteered the information: "It took me two months before I could distinguish my fingers." From this one may conclude that a finger agnosia had been present in the beginning of the disease.

It was observed on several occasions that the patient apparently failed to perceive objects lying in the right half of the visual field. For example, in building words from cards bearing single letters he would fail to use any that happened to lie to the right of the central vision. As already recorded, he also was unable to straighten the sheet on the right side of his bed. This is of interest in that Lewandowsky and Stadelmann,[2] Peritz,[3] Gerstmann,[6] Herrmann[7] and Lange[8] reported the presence of hemianopia in association with acalculia. Repeated perimetric studies, using stimuli of various sizes, failed to reveal any hemianopia or scotoma. Tests for the recognition of objects, their size, number or geometric pattern when located in the peripheral fields of vision failed to reveal any differences between the two lateral halves of the patient's fields of vision or from the results with normal controls. Hence, we are unable to explain the deficiencies noted in the vision of our patient.

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9. Low, A. A.: A Case of Agrammatism in the English Language, Arch. Neurol. & Psychiat. **25**:556 (March) 1931.

On the basis of this preliminary examination the disturbance was summed up as an acalculia plus agraphia, with some apraxic but no gross aphasic symptoms. More detailed studies were then undertaken and will be described.

CALCULATION

1. *"Pure" Calculation.*—(*a*) Description of Mistakes: In mental figuring the patient was unable, even after six months of daily instruction, to make the simplest subtractions and divisions. Once only did he say that 10 minus 2 equals 8. This isolated success must be rated as random. In divisions he never reached a correct solution even in a chance answer; when asked, for example, how much is 6 divided by 2, he would think and strain and finally say: "I don't know that." In additions, he had preserved the faculty of adding 2 digits the sum of which was less than 10, as in $4 + 3 = 7$, and of adding a digit to 10 or 20, as in $10 + 8 = 18$; $20 + 7 = 27$. In all other additions he made constant mistakes, as in $6 + 5 = 12$; $11 + 2 = 12$; $14 + 6 = 32$. Simultaneous addition of three digits was practically always missed: $1 + 3 + 4 = 6$; $4 + 5 + 6 = 14$. In multiplications alone did he show some moderate progress toward the fourth month of intensive daily training. At that time he succeeded in managing the simple multiplication table and was able to execute, with only minimal mistakes, operations like $7 \times 2 = 14$; $6 \times 12 = 72$.

After writing down the problems dictated (here called figuring to dictation), he was completely defective and incapable of learning the simplest subtraction and division. In additions, his capacity was limited to primitive operations, like $3 + 6 = 9$; $10 + 6 = 16$. Anything more complex was bungled: $14 + 6 = 21$; $17 + 4 = 23$. In multiplications, he showed from the onset some proficiency in such simple performances as $2 \times 5 = 10$; $6 \times 4 = 24$; but the number of mistakes far outweighed the average of correct solutions. However, toward the end of the period of observation he made, under training, similar progress as in mental figuring.

When the problem, instead of being dictated, was written on a slip of paper and exposed for from five to fifteen seconds, and the patient was asked to figure the problem out in writing, the result showed the same types and approximately the same proportion of mistakes as in mental figuring and in figuring to dictation.

When an addition was carried out on paper, in the customary columnar arrangement, the vast majority of the results were faulty.

5	12	123
6	15	258
—	—	—
12	27	911

However, considerable progress was noted in written out calculations in the fourth month of training. The improvement extended even to subtraction, but not to division.

Comment.—One essential point in which mental figuring differs from dictated, exposed and completely written out calculations is the entire absence of visual facilitation in the former operation as against the proportionately increasing degree of visual facilitation in the last three operations. Since the introduction and graded accentuation of the visual factor in the last three operations gave no improvement in the results, the inference was that the fundamental defect could not be

ascribed solely to the patient's being of either a predominantly "visual" or a predominantly "auditory" type. However, some sort of visual element, though not in the nature of facilitation, seemed to be operative in some mistakes which will be cited later.

(*b*) Analysis of Mistakes: When the patient said or wrote $36 + 5 = 33$ and, on being checked, "corrected" the answer to 30, the response was plainly a random solution and left no room for an interpretation on the basis of an underlying mechanism. The majority of mistakes, both in mental figuring and in written operations, however, revealed well defined mechanisms. They were: (1) substitution of one operation for another, as described by Berger;[5] (2) substitution of counting for calculation; (3) recapitulation of a digit, and (4) reversal of digits.

Illustrations of these mechanisms are: (1) A substitution of operations took place in $2 + 4 = 8$; and $2 + 8 = 16$. In these instances the patient, when asked to do an addition, performed a correct multiplication instead. An analogous substitution was $2 \times 6 = 8$; $2 \times 5 = 7$. Addition was here substituted for multiplication.

A type of substitution that was rather unexpected was $8 + 5 = 3$; $7 + 2 = 5$; $6 + 5 = 1$; $9 + 3 = 6$, when subtraction was substituted for addition. This observation was in striking contrast with the fact that the patient failed completely, on request, to perform even the simplest subtraction. The conclusion was drawn that the patient was able at times to perform a simple subtraction *spontaneously* but never on request, i. e., as a *"task."*

(2) Substitution of counting for calculation occurred in $5 + 7 = 8$; $16 + 6 = 17$, and $14 + 13 = 15$. In the example $5 + 7 = 8$, the patient counted from 7 to 8. In $16 + 6 = 17$, he counted from 16 to 17. In $14 + 13 = 15$, the counting process needs no explanation.

(3) A recapitulation of a digit was effected in $5 \times 4 = 24$. The 4 of the multiplicator was recapitulated in the product. Similar recapitulations were $32 + 5 = 45$, and $6 \times 7 = 47$.

(4) Examples of reversals are: $23 + 6 = 32$; $13 + 6 = 31$. The digits of the augmend were reversed in the sum.

No difference was noted, either in the type or in the proportion of mistakes, between mental figuring and written calculations. In the recapitulations and reversals the previously mentioned visual element came into operation.

(*c*) Time Factor: In mental figuring it was possible only to measure the time interval that elapsed between the offering of the task and the rendering of the solution, i. e., for the total process. For $7 + 5 = 13$, the total lapse was eighteen seconds. In dictated, exposed and completely written out calculations, a fractioned measuring was applied, separate times being registered for the act of writing down the task, for the intervening act of deliberation and for the final act of writing the result. Thus, for the problem $8 + 5 = 14$, the respective times were ten seconds for writing $8 + 5$; twenty-one seconds for deliberation, and six seconds for writing 14. Attempts to find out whether correct performances required more time than mistakes or vice versa proved futile. There was no regularity in the time element with regard to mistakes and correct results. In those operations only in which the patient had from the outset retained a limited proficiency, as in $3 + 4 = 7$ and $10 + 2 = 12$, was there a regular reduction of the time interval, the various times for the solution ranging between two and ten seconds, with an average of about six seconds per solution. Toward the end of the period of observation, such primitive additive problems still required from two to ten seconds, while simple multipli-

cations were regularly solved instantaneously, with hardly a measurable time interval. This conspicuous elimination of the interval proved that the multiplication table had actually been "learned," i. e., had become a mechanically mastered process. The patient had no longer to calculate and deliberate, but could reproduce the learned result from memory. He had reached the stage, generally aimed at in school training in arithmetic, when simple operations become automatic. That this result was achieved in multiplication only is apt to throw light on a basic difference between this operation and the others.

(*d*) General Approach to Mathematical Problems: After the patient had either solved or failed in a given task, he was asked to repeat the problem. In this manner his capacity for retaining a problem in mind (immediate retention) was tested.

$26 + 5 = 32$. (What did I ask?) Answer: $16 + 30 + 5$.
$36 + 5 = 33$. (What did I ask?) Answer: $25 + 6$—.
$1 + 3 + 4 = 6$. (What did I ask?) Answer: $4 + 2$ is 6.
$2 + 5 = 10$. (What did I ask?) Answer: 2×5 —.
$2 \times 5 = 7$. (What did I ask?) Answer: 2 and 7.

Comment.—If in the problem $26 + 5$ the numbers 26 and 5 are called the components and the word "plus" the sign, the patient was obviously not able to retain either components or signs. But the possibility was that it was not so much a matter of retention as one of recognition and understanding. In addition, if it was a matter of retention, it is possible that while the patient was unable to retain components and signs within the context of a mathematical problem, he might be able to retain them if they were offered outside such a context. To examine these possibilities the following tests were devised:

Manipulating components and signs outside mathematical contexts. The patient was given instructions about the meaning of the signs "plus," "minus," "times" and "divided by," and was asked to write the symbols ($+ - \times \div$) to dictation. He performed well in many repetitions. When he was again offered mathematical problems, he immediately confused the signs in the context of the task. He was then asked to write down series of 3, 4 and 5 numbers which were dictated simultaneously: 3, 6, 10 were written correctly in seven seconds; 4, 5, 9, 10 in five seconds; 5, 7, 14, 19 were changed to 5, 7, 19, 14 in sixteen seconds; 2, 5, 7, 9, 10 were written correctly in seven seconds; 11, 13, 17, 20 were rendered as 11, 31 (instead of 13), 12, 30. When the patient was directed to write similar series of simple numbers that were exposed in writing for a brief period, the results were practically the same.

Comment.—The tests showed that the patient had a fair span for immediate retention of both components and signs outside the context of a mathematical problem. If he had difficulty in retaining them within the context of the problem it was obviously due to some complexity inherent in the "context."

Additional information on the patient's approach to mathematical problems was obtained from an examination of his written performances. Here again, components and signs were not retained. In addition, it was observed that when he was asked to write $4 + 6$ he invariably wrote $6 + 4$; $3 + 6$ was changed to 6

+ 3; 5 + 7 to 7 + 5; 5 + 6 to 6 + 5, etc. In other words, the higher digit was always placed as augmend, the lower digit as addend. The reverse change never took place.

Browne,[10] in an experimental study of fundamental arithmetical functions, found that college students had considerably more difficulty with those addition columns in which the augmend was smaller than the addend and proportionately less difficulty with columns in which the augmend was larger. The behavior of the patient, therefore, seems to indicate that by starting out with the larger number he tended to facilitate his task.

Summary of the Span for "Pure" Calculation.—The inventory taken at the beginning of the study showed some residual proficiency in the simplest additions and multiplications, but a complete deficit in subtractions and divisions. Under training, mental figuring improved in multiplication only. Written calculations showed a marked progress in both addition and multiplication, some slight advance in subtraction and a complete standstill in division. The mechanisms underlying the mistakes were: substitutions of operations, substitutions of counting for calculation, recapitulations and reversals. The time factor showed no regularity in its relation to correct and wrong solutions. Immediate retention for mathematical problems was very poor, both for the components and for the signs of a problem. However, retention was fair for both of these elements outside a mathematical context. In additions, the larger number was always placed in the position of the augmend.

2. *Application of Arithmetical Thinking to Experience.*[11]—(*a*) Mental Figuring with Objects: Addition. The patient was asked: A man has 5 automobiles and 3 trucks. How many vehicles? Answer: "7 trucks." (What did I ask?) Answer: "5 trucks and 3 automobiles are 7—8." In repeated attempts he was unable to hold apart automobile, trucks and vehicles. He constantly repeated: 5 trucks and 3 automobiles or: 3 trucks and 3 vehicles, etc. Three men and 6 women were correctly added together as 9 persons; 6 shirts and 4 suits were correctly given as 10 pieces of wearing apparel. But when the patient was asked to add together 2 groups of objects the sum of which exceeded 10, he failed in most questions: 12 apple trees and 5 cherry trees were given as 7 trees altogether (spontaneous subtraction); then it was "corrected" to 15 (recapitulation of 5). Addition of 3 groups of objects, like the computation of the total population of a village that has 20 men, 15 women and 40 children, was not even attempted. Addition of coins gave similar results: 2 dimes and 1 nickel were promptly computed into 25 cents; but 2 dimes, 1 nickel and 3 cents were added into 21 cents. Adding of time elements resulted in complete failure. He was told: It is now 8 o'clock. What will it be in three hours? Answer: "5 o'clock" (spontaneous subtraction). The addition of spatial entities was also completely beyond his span. Question: A man is on the fourth floor and goes up 5 stories. Where will he land? He was unable to answer. Likewise he was unable to repeat the problem that had been asked.

10. Browne, C. E.: The Psychology of the Simple Arithmetical Processes, Am. J. Psychol. **17**:1 (Jan.) 1906.

11. A few examples only of the tests contained in the protocols are here quoted.

Comment.—In adding 5 automobiles and 3 trucks, the patient had to deal (1) with numerical components (5 and 3), (2) with objective components (automobiles and trucks) and (3) with the sign "and." The introduction of the objective component aggravated the task, and the performances were generally far inferior to those in "pure" calculation. Questions pertaining to time elements and spatial entities were never correctly answered. Recapitulations and substitutions of operations were frequent. Of 19 questions, 7 were answered correctly.

Multiplication. The results were decidedly better than in addition. Of 24 questions, 12 were answered correctly. The type of questions asked was: A sheep has 4 legs. How many legs have 15 sheep? How many quarters are there in 3 dollars? How much do 2 cigars cost if one costs 15 cents? Questions pertaining to time and space elements yielded again a total failure.

Subtraction. Four correct answers were rendered to a total of 17 questions. The type of questions was: 20 boys are in a class; 3 leave the room. How many are left? A man has 2 fingers of his hand shot off. How many fingers are left?

Division. Of 10 questions, 4 were answered correctly. Although the correct answers were given to such simple questions as: divide an apple between 3 children; how much will each child get? the result was measurably better than in "pure" arithemetic, in which a solution—correct or incorrect—was never even attempted.

(*b*) Arithmetical Manipulation of Objects: Monetary objects. Addition: One-half dollar, 2 quarters, 7 dimes, 3 nickels and 5 pennies were placed on the table. When asked to give the examiner 75 cents, the patient picked promptly 1 half dollar, 2 dimes and 1 nickel. In like manner he picked the correct coins for 78, 67 and 83 cents. When dollar bills were added to the former batch of money, he picked the correct bills and coins for 7 dollars and 42 cents, 8 dollars and 77 cents, etc. Generally he produced more correct than wrong performances. Also, he generally picked the correct amount of money when the amount desired was written on a slip of paper.

Various boxes tagged with a price were placed on the table. The patient was told: I want to buy this article and this one ($7 and $3). He said: "You have to pay $10." For 2 articles, priced $5 and $2.50, he asked $7.50. On the whole, he gave a considerable number of correct answers.

Multiplication: Examiner: I want two boxes like this one ($7). He first made mistakes and then corrected to $14 when he was checked. For 4 boxes of $7 each he asked $28; for two boxes of $2.50 he asked $4.60, but corrected spontaneously to $5. Mistakes and correct answers were more or less evenly balanced.

Subtraction: The examiner bought a box for $1.55 and paid with a 2 dollar bill. He returned 55 cents as change (recapitulation). For an article priced $5.25 he received $6 in bills; he returned 25 cents. Once only was the correct change of 10 cents returned when a quarter was paid for a 15 cent cigar.

Division: The patient was asked to distribute 6 quarters equally between 3 cubes. He made random attempts and soon gave it up.

Nonmonetary objects: Addition: A heap of beans was on the table. He was able to sort out 6 beans and 5 beans, and to indicate their sum as 11; 5 beans and 11 beans were added together as 13 beans; 8 and 5 beans were 14; 18 and 15 beans were 22.

Multiplication: He was asked to place 5 tablets in front of each of 3 sticks. He performed correctly and gave the product as 15. However, the product of 7 tablets added to each of 3 sticks was given as 18.

Subtraction: He counted correctly 15 beans, took off 3 and gave the difference as 13. No correct answer was given in a number of similar tasks.

Division: Tasks like the distribution of 6 beans between 3 sticks were beyond his grasp.

Comment.—In general, the mathematical manipulation with objects gave better results than mental figuring with objects. Monetary units were manipulated with greater facility than nonmonetary objects.

COUNTING

1. *Mental Counting.*—The patient counted from 1 to 20 correctly in five seconds. He was also able to count off any continuous series of numbers, e. g., 990, 991, 992, etc.; or 10,000, 20,000, 30,000, etc. Backward counting was always deficient.

He performed rather well in the 2-count, 3-count and 4-count. For instance, 2, 4, 6, 8, 10 was followed correctly up to 50; 3, 6, 9, 12 was followed up to 36, when he skipped members of the count and continued—partly within the count—42, 54, 62. On a second attempt he counted 3, 6, 9, 12, 14, 16, 18; i. e., he changed into the 2-count. The 4-count was given as 4, 8, 12, 16, 24, 36, 42, 54, 60.

The patient was able to correct the examiner when the latter, while counting, left out a number, even in the higher reaches of the number series.

Days and months were named correctly in the forward series, but never in the reverse series.

He indicated correctly the number of syllables in words with 2, 3 and 4 syllables when they were called out to him, in from fifteen to thirty seconds.

2. *Counting of Objects or Acts Arranged in a Continuous Series.*—A flashlight was flashed in quick succession 3, 4 and 5 times. The patient counted the flashes with only a few mistakes.

The examiner tapped the table with his fingers from 3 to 6 times in rapid succession. The patient counted correctly.

Three, 4 and 5 pills were placed in one or the other hand to be counted without looking. The patient gave many correct and some incorrect counts. (Control tests on various persons and on the examiner himself showed that normal persons make about the same type and number of mistakes in tactile counting.)

The patient counted various groups of tongue depressors correctly; he was also able to pick 4 out of 10 and promptly pointed to the second, fourth and eighth tongue depressor. He was able to separate half from a group of 4, 8 and more tongue depressors.

He was able to count correctly irregular heaps of beans or pills up to 10. But 18 were counted as 17, 21 as 24, 24 as 20, etc.

3. *Counting of Objects Arranged in Discontinuous Groups.*—He was shown 20 pills in 4 equal (homogeneous) groups (fig. 1, *4a*).

The 20 pills were then offered in similar (homeogeneous) groups (fig. 1, *4b*).

The same 20 pills were then offered in similar (heterogeneous) groups (fig. 1, *4c*).

In the same manner, all the numbers from 11 to 30 were offered in homogeneous, homeogeneous and heterogeneous arrangements, and also in straight chains. In addition, the pills were varied in color, shape and size so that of 20 pills, 6 were brown, 5 dark red, 5 yellow and 4 white. Or, 20 red pills were composed of 3 square, 6 oblong, 6 round and 5 square specimens. The result was that the patient made almost constant mistakes with any number above 10, no matter what the arrangement was with regard to size, form or color.

Comment.—When the 20 pills were arranged in 4 groups of fives, it would have been possible for the patient to count the first 5 and then to multiply by 4. In that case, the total count would have required less time than when the pills were arranged in groups of 5, 6, 4, 2, 3. The fact that no variation in time was observed showed that the patient always counted and never multiplied, regardless of the arrangement.

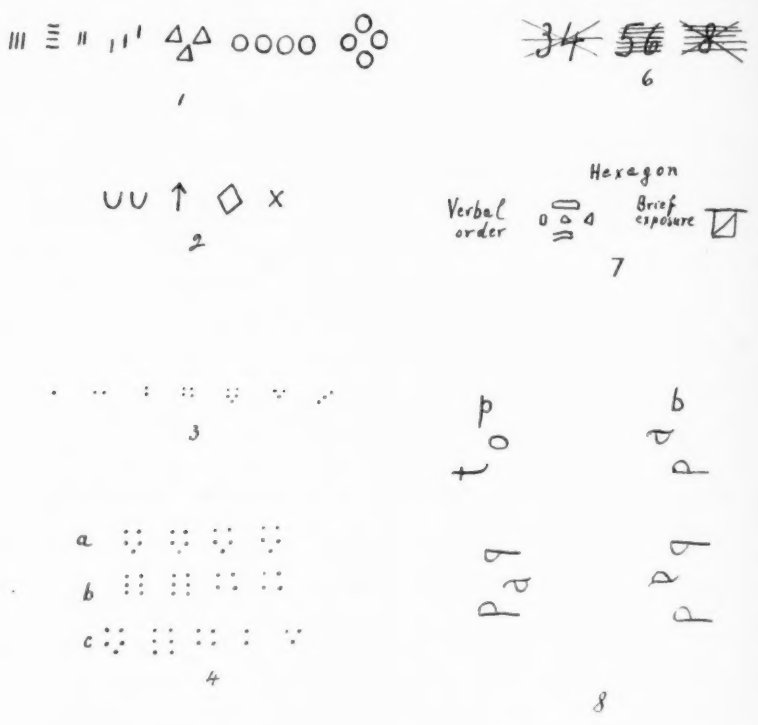

Fig. 1.—Samples of patient's ability to perform tests.

He consumed less time for small numbers and more for larger numbers: 6 pills were counted in many repetitions in an average of seven seconds; 8 pills in an average of fifteen seconds; 18 pills in an average of twenty-five seconds, and 24 pills in an average of thirty-nine seconds.

John Locke,[12] and later many philosophers, psychologists and pedagogs, assumed that the faculty for arithmetic operations is dependent on the ability to count. "A child," said Locke, "knows not that three

12. Locke, John: An Essay Concerning Human Understanding, ed. 39, London, William Tegg Company, 1875, p. 18.

and four are equal to seven till he comes to be able to count seven." Locke did not specify whether he referred to mental counting within the continuous number series or whether he included in his definition the process of counting discontinuous objects. The tests showed that the patient's capacity for mental counting was practically intact, whereas in counting discontinuous objects he was as helpless as in calculations.

SIMULTANEOUS PERCEPTION (TACHISTOSCOPIC GRASP)

1. *Tachistoscopic Reading of Numbers.*—By means of a tachistoscope with one fifteenth of a second exposure, various numbers were offered for reading. Single digits, like 4 and 7, were read promptly; 69 was read as 9-9-6; when the number was exposed a second time, it was read 6 and 9; 35 was read 3 and 5. Various other numbers with 2 digits were similarly dismembered at the first reading, but were usually read correctly at the second exposure. Rarely were they rendered correctly at the first reading.

Numbers consisting of 3 digits were always dismembered and never read correctly before the third or fourth exposure; for example, 472 was read: 1-47; 42-2; 47; 4-7-2, on sucessive exposures; 1250 was read: 2-50; 1-50; 1-0-5; 1-2-5; 1-2-5-0. When the number was finally rendered correctly after the third, fourth or fifth exposure, it was read dismembered; 1300 was read correctly as thirteen hundred; 22100 as twelve hundred, two thousand and twenty-two hundred. A number with 4 or 5 digits without a zero was never read correctly, even after 6 or 7 exposures.

No improvement of performance was obtained when the numbers were given a marked arrangement (fig. 1, *5*). When crossed out numbers (*Strichfiguren*) were given, after Goldstein and Gelb,[13] the patient was not at all embarrassed by the crosses. The crossing was done as shown in figure 1, *6*.

When the patient was directed to write down the exposed number instead of reading it, he encountered the same difficulties, dismembered the numbers and wrote the full number after several exposures only.

Comment.—Tests performed on normal persons with approximately the same education as the patient showed that they were uniformly able to read numbers with 3 digits at the first reading. The test therefore demonstrates that the patient lacked the faculty of simultaneous perception of 3 consecutive digits. That numbers with specially marked digits offered no facilitation and that crossed out numbers caused no aggravation of the task proved that a visual "Gestalt" factor was not responsible for the lack of tachistoscopic grasp. There was a greater tendency to grasp the digits to the left of a number than those to the right.

2. *Tachistoscopic Grasp of Signs.*—From 1 to 5 points were exposed in various arrangements (fig. 1, *3*). The patient was never able to indicate the number of points correctly, not even the number 1. Even after 6 or 7 exposures he still

13. Goldstein, K., and Gelb, A.: Psychologische Analysen hirnpathologischer Fälle auf Grund von Untersuchungen Hirnverletzter, Ztschr. f. d. ges. Neurol. u. Psychiat. **41**:1, 1918.

made mistakes. When he was asked to draw what was exposed, he invariably drew circles instead of points (of course, the wrong number of circles). Even after he was told the difference between points and circles and showed that he grasped this difference, he again substituted circles in immediately succeeding tests. When the points were exposed outside the tachistoscope, he was well able to indicate their number and to designate them as points. When dashes or small triangles or circles were offered instead of points (fig. 1, *1*), the number of the exposed figures was sometimes named and drawn correctly, even after 1 or 2 exposures, provided they were not more than 2. The dashes were even drawn in their correct spatial arrangements as horizontal, vertical and oblique dashes.

Various figures, like those shown in figure 1, *2*, were correctly drawn.

Comment.—The fact that the patient, after numerous trials, was unable to recognize a point tachistoscopically seems to be of particular significance. A point is, in essence, no number at all and represents, if anything, merely an element that has no spatial extension. It is, so to speak, the negation of space. Two points represent, aside from their spatial meaning, a multiple, i. e., a number in the abstract. It is also significant that a point is a whole that has no parts.

3. *Tachistoscopic Reading of Words.*—Monosyllabic words, like dog, bed and man, were offered for reading. Of 23 words, 7 were read correctly after the first exposure. Some could not be read even after repeated exposures. Others were read correctly after 2 or 3 exposures. In the series of the missed words there was always a gradual improvement in regularly progressive stages, as follows: Bed was read and simultaneously spelled out after the first exposure as d-a-d; second exposure, b-a-d; third exposure, b-e-d; man: first exposure, l-a-w-n; second, l-a-n; third, m-a-n; tip: first exposure, d-e-e-p; second, d-i-p; third, t-i-p. In other words, the last letter of the word was usually first grasped; then came the middle letter; then the first letter. It was a progression from right to left. In the words that were read incorrectly in all exposures, the last letter was almost always grasped and sometimes also the middle letter. A tendency to perseverate manifested itself in the following manner: The word tip was exposed, and the patient read d-e-e-p, d-i-p, t-i-p. Immediately afterward the word quip was exposed, and the patient read: d-i-p, d-e-e-p. Or, the word tap was exposed, and the patient read: t-o-p; immediately following, the words pad and dub were exposed; both words were read as t-o-p.

Bisyllabic words were practically never read correctly. As a rule, the last syllable was grasped or approximately grasped. For instance, fitting was read as m-o-r-n-i-n-g; bumper as h-o-p-p-e-r; letter as b-u-t-t-e-r, and bedroom as a-q-u-a-r-i-u-m. When words were offered that had some intimate relation to the patient's private life, he read them promptly and without spelling them out, even if they consisted of 3 or 4 syllables, e.g., equipment, boilermaker, foreman, Chicago, Sheehy (his name) and Anderson (his physician's name). Nonsense syllables were never grasped, even after several exposures. The last letter or the last 2 letters were usually read. There was less tendency to dismember or to spell out the nonsense words. The syllable tay, for example, was read joy, toy, d-a-y, day; nix was read mix, dix, dix; "por" was read dor, dop, p-o-o-r.

Comment.—The patient's inability to grasp discontinuous entities in a simultaneous act of perception was plainly demonstrated by the tachistoscopic tests. This disability was not confined to the tachisto-

scopic reading of numbers; it extended with equal force to the reading of signs and words. Moreover, there was a marked difference in the mode of operation of the spatial element with regard to reading numbers, on the one hand, and words, on the other. Numbers were read from left to right and words from right to left. The preliminary conclusion was drawn that the spatial factor, more particularly the factor of direction, played an important rôle in the perceptive activity of the patient, but that its influence was not confined to the perception of numerical entities.

GENERAL KNOWLEDGE OF NUMBERS (ARITHMOGNOSIS)

1. *Number Reading.*—Numbers consisting of 1, 2 and 3 digits, like 9, 58, 429, were always read correctly. Numbers of higher value were read correctly when they consisted of 2 digits and zeros, e. g., 25,000 and 340,000. Reading of numbers with 3 digits and zeros usually proved unsuccessful. Toward the end of the training period the patient was able to read practically every number, even up to millions.

Abbreviations and signs were read fluently: $87.50; 40%; 9 a. m. Fractions, like 1/5, 5/90, the patient read with a terminal th, e. g., one-fifth. It must be noted that the patient was not tested for fractions until the fourth month of training.

2. *Number Writing.*—Numbers with 1 or 2 digits were correctly written to dictation. But when numbers above 100 were dictated the patient wrote them in the manner in which they are spoken: 242 was rendered as 20042; 111 as 10011; and 197 as 10097; 2,500 was written 2000500, when the dictation was two thousand five hundred, but when the dictation was twenty-five hundred, the patient wrote 2500. When the examiner wrote down 2500, the patient read twenty-five hundred; but when 2000500 was written, he read two thousand five hundred. When asked to indicate the greater number, he pointed to 2000500.

3. *Recognition of Numbers.*—The patient was shown a sheet on which were printed 54 numbers consisting of 3 digits each, like 257 and 935. The numbers were arranged in 7 vertical and 8 horizontal columns and so distributed that they could easily give rise to confusion. The number 257 of the first horiontal column was changed to 275 in the second and to 725 in the third horizontal column, etc. The patient was asked such questions as: Where is 725? Which is the largest number in the third vertical column? He answered correctly. He was then shown the following columns:

126	652	1026
345	725	935
385	462	462
462	986	729

He was asked: In which column is 462 the largest, and in which is it the smallest figure? He answered correctly.

4. *Manipulation of Figures On Cardboard (Number Praxis).*—The patient was shown 4 pieces of cardboard, bearing the digits 5, 4, 0, 0. He read promptly five thousand four hundred. The cards were shuffled together. He rearranged them correctly on request in seventeen seconds. He performed equally well with other arrangements of 3 and 4 digits. An assortment of 25 digits was then put on the

table and he was instructed to pick three thousand two hundred and fifty. He placed the cards in the following order: 2-5-3-0-0-0, beginning from the right. When he was checked, he rearranged them as follows: 3-0-0-0-0-5-2; the 3,000 was arranged from left to right, and the 250 from right to left. One thousand two hundred and fifty was arranged: 0-5-2-0-0-1, all from right to left; when he was checked he "corrected" to 0-5-0-0-2-0-0-0-1, all from right to left. Various attempts to teach him how to avoid the mistake were without avail. *In contradistinction to what the patient did in analogous tests with letters,* to be described later, *he did not, in placing the digits, deviate from the vertical or horizontal line of conduction.*

5. *Knowledge of the Number Concept.*—The patient was asked: Which is more, 305 or 503; 1520 or 1770? He answered correctly. To guard against his tendency to recapitulate the last-named number, the questions were so modified that the greater number was named first, e. g., which is more, 875 or 524? The answers were invariably correct.

Which is bigger, ⅓ or ⅙; 1/10 or ¼? Which is more, one hour or thirty minutes, 2 dimes or 50 cents, 2 quarts or 1 gallon? The answers were correct.

What is the population of Chicago? Answer: "3 million." How much does a package of cigarets cost? Answer: "15 cents." How many cigarets are there in a package? Answer: "20."

The patient knew the difference between even and odd numbers. He was able to give his house number and to state of how many digits it consisted.

The digits 1, 8, 3 were called out to him, and he was asked to form a number out of them. He said: "12." When asked why, he answered, "1 and 3 and 8 equal 12." After explanations he said: "183." Other digits like 3, 5, 9; 9, 8, 0 and 1, 0, 7 were then correctly composed into numbers. (Note that the patient was never able on request to add correctly 3 digits as he did here spontaneously in 1 plus 8 plus 3.)

He was told: I shall call various numbers; when I come to 625 you must stop me. The examiner then called 324, 476, etc., and the patient stopped him at 625. Various other performances of this kind were correct. The examiner then wrote down various numbers and asked the patient to stop him when he wrote the number 380. He did so promptly.

He knew which number came before 19, 34, 216, etc.

He was given lengthy instruction (after Peritz [3]) that the digit 1 contains one vertical bar; 3, two semicircles; 4, one cross bar and two vertical bars; 5, one cross bar, one vertical bar and one semicircle, etc. He then promptly indicated that the 6 has one semicircle; 7, one cross bar and one vertical bar, etc.

Comment.—The patient's knowledge of the number concept must be called fair, if not good. The mistakes that he made were again prominently correlated with a factor pertaining to a spatial element. He could not grasp that the 1 in 197 has an entirely different value from the 1 in 21. That this "position value" of digits constitutes a spatial element needs no explanation. The inability to manipulate spatial arrangements was particularly evident in his manner of arranging various numbers from right to left and vice versa.

ESTIMATION OF MAGNITUDES AND QUANTITIES

1. *Objective Estimates.*—Of 6, 8 and 12 tongue depressors, arranged in 3 piles, the patient designated correctly and promptly the largest, second largest and third largest groups. When 7 tongue depressors were placed in the patient's left hand and 9 in his right hand, he said correctly that he had more in his right hand. He filled, on order, a 2 ounce glass with water up to the mark "2 ounces." He compared various glasses of equal size filled with different amounts of water and named correctly the glass with more, less water, etc., ordering them correctly as to their quantity.

The examiner placed a pile of about 200 pills on the table and separated a heap of 60 pills. The patient was asked to separate the same number of pills from the remaining heap; he matched them by 55 pills, merely by sorting without counting. A heap of 26 pills he sorted, without counting, into groups of 13 and 13; 30 pills he divided into 12 and 18; 42 pills into 19 and 23, and 46 pills into 23 and 23. The order was: Divide this heap into 2 equal parts. When larger numbers were offered, he made gross mistakes, as compared with normal controls. For example, he divided 235 pills into 152 and 83 and 152 pills into 64 and 88.

While in all the preceding tests the factor of magnitude predominated over that of quantity, the latter factor predominated in the following tests: twenty-four pills were placed in a small box and 24 pills in another box of the same size. The patient designated them as "pretty near tied." They were put together in one box, and he was asked, how many are they? He said: "about 50." Thirteen pills were so placed in a small box that they overlay each other. He indicated their number as "about 14."

2. *Mental Estimates.*—The patient estimated the length of his middle finger at 3 inches, that of his leg as "about 60 inches," the duration of a dinner as ten minutes, that of a trip downtown as of "at least an hour" (correct), and that of a trip to New York as twenty hours. The speed of an automobile he placed at 50 miles, that of a train at 60 miles and that of an aeroplane at 120 miles.

Comment.—On a priori grounds, it is to be assumed that a successful manipulation of arithmetical problems presupposes a facility for estimating quantities and magnitudes. For example, if one wishes to compute how much the sale of 100 cows will net, one must not state the result in terms of pennies or of a few dollars. One must immediately focus on numbers involving thousands of dollars. The tests showed that the patient was fairly well able to place himself, by estimation, in the approximately correct neighborhood of the expected magnitudes and quantities. A gross inability to effect correct estimates could therefore be ruled out as a possible cause for the difficulties in arithmetic.

MEMORY

The patient was well able to repeat 3 numbers, 3 proper names or 3 simple words in immediate reproduction. After three minutes he usually failed with the numbers, even if they consisted of 1 digit each, but reproduced 1 or 2 of the proper names and words. After six and nine minutes he usually failed in numbers, words and names. Nonsense syllables he could not repeat at all, except when they were offered 1 at a time. The sentence "I visited George on Monday and Joe on Friday" was repeated: "John visited George on Monday and Joe on Friday."

He repeated correctly the following sentences: "A street car goes east, an elevated north and an automobile west." "I eat at the Palmer House on Monday and at the Congress Hotel on Wednesday."

When asked to repeat sentences that contained numbered objects, the patient repeated the objects correctly but not the numbers. "A man has 250 horses and 30 cows" was reproduced as "A man has 50 horses and 25 cows." The sentence "his brother has 85 horses and 250 cows" was rendered: "he has 250 horses and 200 cows" (mark the recapitulation of 250). To ascertain whether he conceived the general meaning of the implied relations, the same sentence was offered in the following version: "A man has 25 horses and 30 cows. Is he wealthy? The answer was: "He is just making a living." He was then told: "His brother has 85 horses and 250 cows. Is he wealthy?" he said: "Yes."

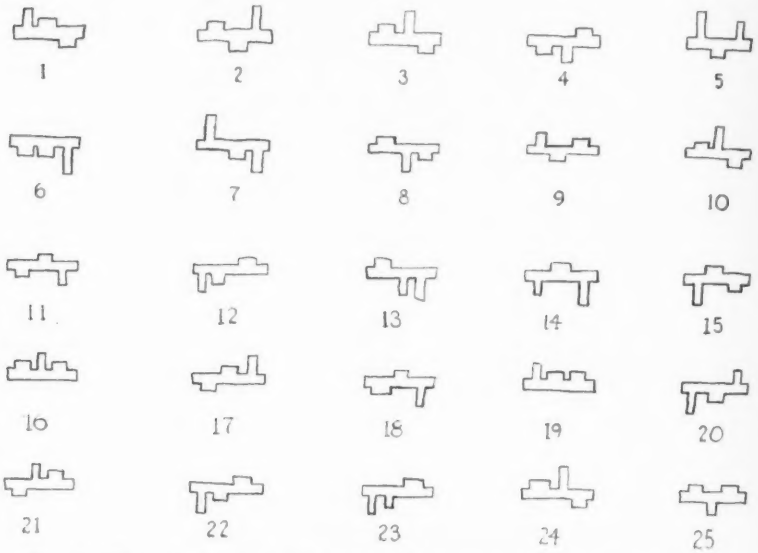

Fig. 2.—Twenty-five designs shown patient as a test for optic memory.

The patient was given a sheet with 42 numbers and told: Keep 12 and 14 in mind and underscore them on this sheet. In four 12's and four 14's he made 1 mistake.

He was given (after Poppelreuter [14]) a sheet of paper with 25 simple designs drawn on it (fig. 2). The examiner had the identical 25 patterns cut separately in his hand and exposed them severally for about three seconds. The patient identified the corresponding designs on the sheet in an average of twenty-two seconds.

Comment.—That memory enters as a prominent factor into the execution of mathematical problems needs no discussion, as it forms an

14. Poppelreuter, W.: Psychologische Begutachtung der Erwerbsbeschränkten, in Abderhalden, E.: Handbuch der biologischen Arbeitsmethoden, Berlin, Urban & Schwarzenberg, 1928, vol. 6, pt. 101.

integral part of every mental activity. The tests showed that the patient was able to repeat isolated numbers. But numbers in their mathematical context (25 horses and 30 cows) he could not repeat. In other words, his immediate retention was preserved for nonmathematical elements and for isolated numbers, but was practically abolished for numbers within their mathematical context. The conclusion was drawn that one of the factors that accounted for the patient's difficulties in manipulating mathematical problems was his defective immediate retention for numbers in their mathematical context.

CHRONOGNOSIS (CONCEPTION OF TIME)

1. *Reading Time from a Watch.*—The patient was able to read correctly the half hours only, 2:30, 11:30, etc. He always said half past eleven or half past two and never eleven thirty or two thirty. No other time relation was read correctly. There was a tendency to confuse symmetrically opposed time markings on the dial; for example, he read a quarter past 12 instead of 11:45 or 12:00 instead of 6:00 or a quarter to 9 instead of 3:15. When he was asked to indicate on a dummy watch the same time that the examiner showed him on his own watch, he made very few mistakes with the half hours 3:30, 10:30, etc. In all other time relations he made the same types of mistakes as in reading from one watch. The same results were obtained when the time was written on a slip of paper and the patient was instructed to arrange the hands of the dummy watch accordingly.

2. *Estimation of Time.*—The patient was asked, which is more, three minutes or twelve seconds; two months or five weeks? He gave correct answers. Contrary to expectation he did not recapitulate the last number. He estimated correctly the examiner's age. He was able to tell approximately how long he had been at the hospital and in what month and on what day he had arrived there, and he was well able to name the current day and month.

3. *Reproduction of Time Data Belonging to General Information.*—The patient knew that Tuesday came before Wednesday and March before April. Christmas he placed on the twenty-fifth day in January; Easter "somewhere in April." He knew his age and the date of his birth. He was able to give in detail the date on the day of this examination as "Monday, January, 1930, about the 8th."

Comment.—The patient had a fair ability to estimate time and to reproduce time data referring to general knowledge. His deficiency in reading the time from a watch was in rather marked contrast with his general understanding for time concepts. Here again, however, the elements of spatial orientation and of immediate retention of numbers within a context seemed to play an important rôle. The spatial element came prominently into play when he confused symmetrically opposed time markings, like 12:00 and 6:00. Since we knew from previous tests that simple numbers, like 6 and 12, did not appreciably tax his retentive memory, the inability to distinguish these numbers on a watch must be attributed solely to the spatial and contextual elements.

LETTER, WORD AND SENTENCE GNOSIS

1. *Manipulation of Letters and Words.*—The small letters a to g were placed on the table and the patient was told to arrange them in their proper order. He was always able to do this correctly. *However, most of the letters were placed either above or below the horizontal line of conduction; furthermore, there was a tendency to place the letters at various angles of deviation from the vertical axis* so that the letters were set obliquely or stood upside down or were parallel with the horizontal instead of the vertical line (fig. 3). The same types of misplacement were observed with the capital letters (fig. 3) of the alphabet and with the numerals 1 to 9 (fig. 4). Analogous mistakes in spatial arrangement were made when single letters were to be combined into words or words into sentences. The

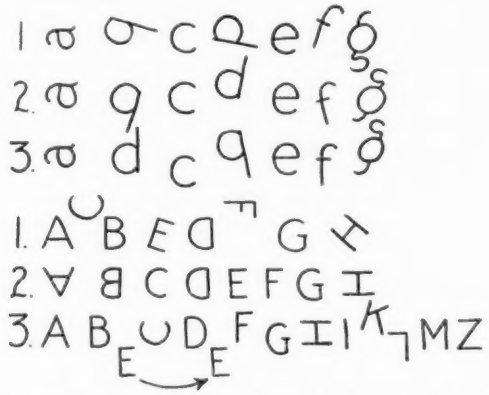

Fig. 3.—Arrangement of small and capital letters made by patient.

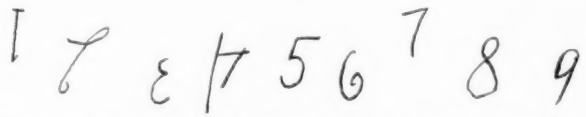

Fig. 4.—Arrangement of numerals 1 to 9 made by patient.

order of succession was thereby always found correctly, but the spatial arrangement with regard to the horizontal and vertical was always distorted. For example, when the patient was given the letters p, o, t, with the request to arrange them into "pot," or b, a, d, he arranged them as shown in figure 1, *8*. The succession was again preserved.

Reversals of the initial and terminal letters were frequent, but the central letter was always left in the center. The patient was asked to arrange the letters p, o, t into "pot" and reversed them into t-o-p. When the letters p-o-t were placed before him, he sometimes read them as "pot" and sometimes as "top." Similar mistakes, both in arranging and in reading, were made with b, a, d and g, o, d. With nonsense words, like "mun," "nom," and "mok," he made the same types of mistakes.

Three each of the letters b, d, p and q were placed on the table, and the patient was directed to pick out the letters to order. He made few mistakes in numerous tests.

2. *Writing.*—Whether from copy, from exposure or to dictation, writing was reduced to an illegible scribble in the first few weeks of the testing period. This scribble was always placed on the right half of the sheet of paper (fig. 5). The patient would start in the middle of the sheet and write one word; the next word would be placed on the next line a move farther to the right. In the next line the word was placed still farther to the right, etc. He was not able to maintain the line of conduction. The displacement to the right and the missing of the line of conduction persisted for many weeks, even at a time when he had improved both in caligraphy and orthography. After he had improved under daily training, his writing exhibited the following types of defects:

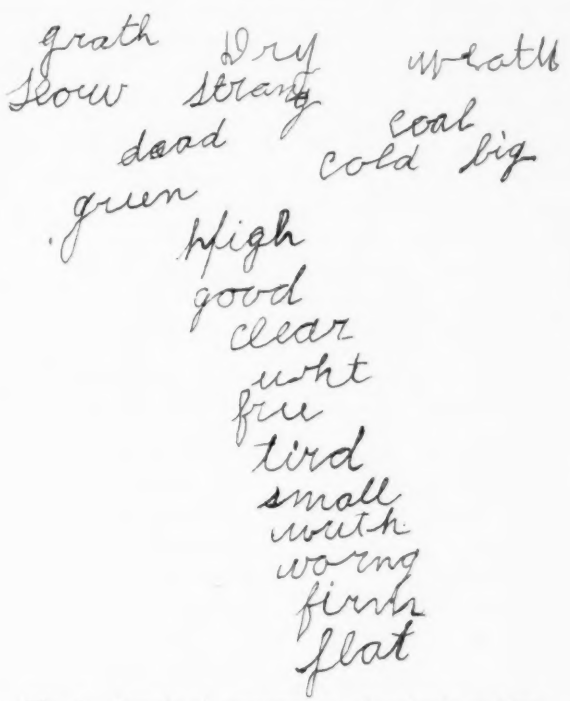

Fig. 5.—Sample of arrangement of patient's writing.

(*a*) Writing from copy: The examiner wrote the sentence "Mary picked one poppy" on a slip of paper. The patient copied "Mary kicked kokey." In other words, the k in the middle of the word "picked" was anticipated and placed at the beginning (ante-position); afterward, the k was recapitulated and "kokey" written instead of "poppy." Other instances of antepositions were: "thoes" for those; "Staurday" for Saturday; "Saturady" for Saturday; "umberla" for umbrella; "Sepmebrer" for September, and "nan" for man. When "howo long" was written for "how long," the mistake might have been an anticipation of the o from the succeding "long" or a recapitulation from the preceding "how." An undoubted recapitulation took place when "I have a hook" was written for "I have a book."

In some of the copied sentences the words were juxtaposed without an intervening interval of space, e. g., "wewriteinthisway"; "thismanisreading"; "chicago-

ill"; and "whatisthis." In other sentences an elision of letters occurred, so that the words were not merely juxtaposed but actually fused together. Such fusions were "wherarey" for "where are you"; "wherdoulive" for "where do you live," and "howlng is thfirst line" for "how long is the first line." Elisions of letters in single words were frequent; the word "studying" was copied as "studing," "stdying" and "stying"; "September" was copied as "Setember," "Septmber," "Sepember"; the word "Saturday" was copied "Saurday," "Surday," "Sturday."

(*b*) Dictation: The anticipations, juxtapositions, elisions and recapitulations were not as frequent as in writing from copy. Most of the mistakes were orthographic in nature. Monosyllabic words yielded the relatively best performance, regardless of whether they were nouns, adjectives, verbs or prepositions. In bisyllabic words the mistakes became more numerous, and polysyllabic words were practically never written correctly. In order to discover a possible regularity in the type of mistakes, the same word was offered on different days. However, the same word furnished different mistakes on different days. Thus, profit was once written as "proffith" another time as "boffth"; teacher once as "thechet," then as "checer"; business as "biaas" and "bisos," and practical as "practle" and "prirelh."

(*c*) Writing from Exposure: Words and sentences were exposed for about thirty seconds. The mistakes were practically the same as in writing to dictation.

3. *Reading.*—The patient read fluently any kind of material, sense or nonsense, letters, syllables, words, sentences and paragraphs. He was able to read a word, like CHICAGO both in a reversed and in a vertical arrangement. He also read sentences in which words were juxtaposed, like: IWENTTOTHESTORETO-BUYSOMETHING. The sentence "The big dog ran out of the house" (Dearborn [15]) was given the patient in mirror script. He was unable to read it.

Comment.—That the main mistakes noted in writing had in common an inability to handle certain spatial elements seems obvious. The anticipations and juxtapositions certainly belong to this spatial category. That the displacement to the right, the deviation from the line of conduction and the reversals of the initial and terminal letters are due to some sort of lack of spatial recognition goes without saying.

DRAWING

The patient was asked to draw objects like an apple, a pear, a shoe, a church, a pipe and a cigar to verbal order. The examiner then drew each object on a piece of paper, exposed it for about thirty seconds and the patient reproduced it. Then, the object was placed both as such and as a drawing on the table, and the patient was asked to copy it. The results, as shown in figures 6, 7 and 8, may be summarized as follows: There was slight improvement in the patient's copying as compared with his drawing after brief exposure or to verbal order. The performance was generally better with objects and patterns that had a symmetrical arrangement (house, bottle, table, box, apple, human face) than with objects and patterns that were more or less asymmetrically arranged (church, shoe). Complex drawings like a hexagon he could not reproduce in spite of their marked symmetry (fig. 1, 7).

15. Dearborn, W. F.: The Etiology of Congenital Word Blindness, Harvard Monographs, Educational Series 1, June, 1925, vol. 2, no. 1.

It was always ascertained that the patient knew the use and meaning of the objects and patterns he was asked to draw. In his former occupation he had had to make sketches of the jobs he superintended. With such figures as a hexagon he was familiar.

He was able to draw a line between two points and to connect three points into a triangle. When a line was drawn on paper by the examiner, the patient was well able to halve or double it.

In drawing a ground plan of the examining room, on request, he missed the proportions of the furniture and their location relative to each other and to the room, and inserted 3 doors instead of 2.

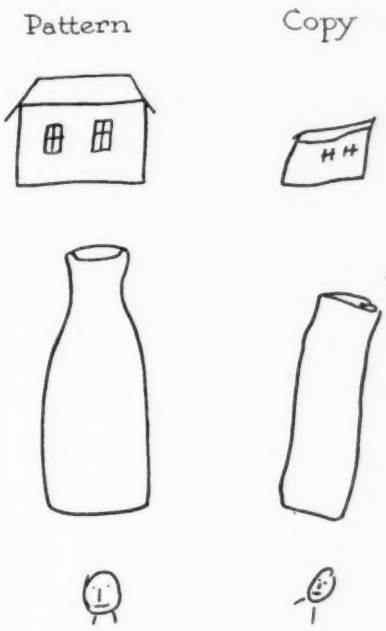

Fig. 6.—Drawing after pattern.

When the object or pattern to be copied lay perpendicular to the patient's body, he invariably drew it inclined to the right. He was unable to draw any straight line, whether horizontally or vertically, and always deviated to the right of the vertical and above or below the horizontal line. This deviation took place regardless of whether he started out from above or below or of whether he drew the lines by themselves or in the context of another figure.

In spite of constant attempts to correct his drawing, practically no result was obtained throughout the period of training.

Comment.—That the spatial element is all important in drawing is understood. The tests seem to prove that this spatial element is prominently associated or perhaps identical with the factor of symmetry. What requires particular comment was that drawing from copy gave no appreciably better results than drawing from memory. In other words, the defect was such that visual facilitation gave little aid. It is

also worth noting that the results were no better when the patient copied from the actual object instead of from the examiner's pattern. The deviation from the vertical and horizontal line is a feature that has already been noted in the tests for writing.

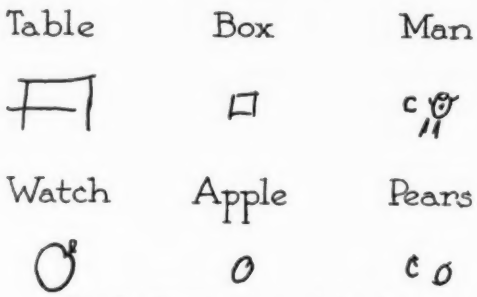

Fig. 7.—Drawing on verbal order.

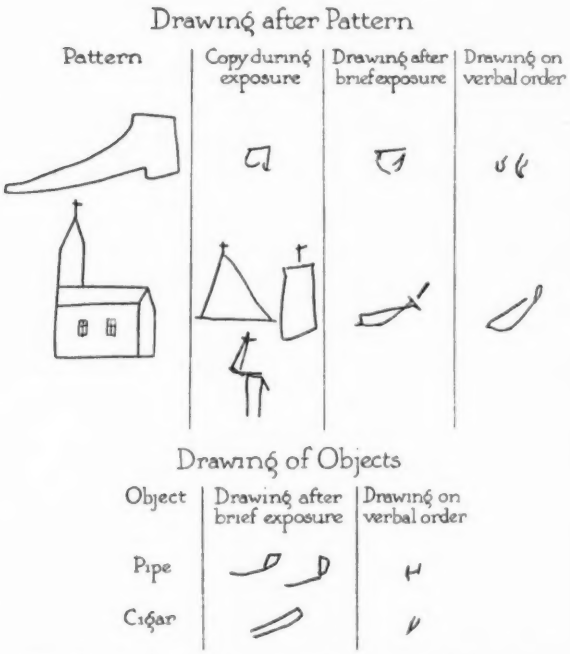

Fig. 8.—Drawing after pattern and on verbal order.

SPATIAL GNOSIS

1. *Manipulation of Objects in Their Spatial Relations.*—Small sticks were placed on the table in various arrangements, as suggested by Strauss [16] in his study of "constructive apraxia." In most cases the patient was unable to reconstruct the

16. Strauss, H.: Konstruktive Apraxie, Monatschr. f. Psychiat. u. Neurol. **56:** 65, 1924.

pattern. While he manipulated the sticks the original pattern was left exposed on the table. The relationship between pattern and copy is plain in figure 9.

Seven tongue depressors were arranged in parallel groups of ll lll ll and then thrown together. The patient rearranged them as lll ll ll. In many repetitions with 7, 8 and 9 tongue depressors he made constant mistakes.

Triangles, squares and quadrangles of various sizes were cut out of paper. When asked to cut similar figures, the patient was at first helpless, but he performed well after due explanation. After he understood the task he cut the figures correctly on plain order without being shown a pattern.

Both on plain order and after demonstration, the patient was able to cut away the upper corners of a square, the left upper corner, or all the corners together. On order and after pattern he cut a triangular notch in the lower, upper or lateral sides of a square.

Six triangular, rectangular, quadratic and pentagonal "windows" were cut out of a piece of cardboard. The patient was asked to put the "windows" back into their frames. After initial mistakes he performed well in many repetitions. The

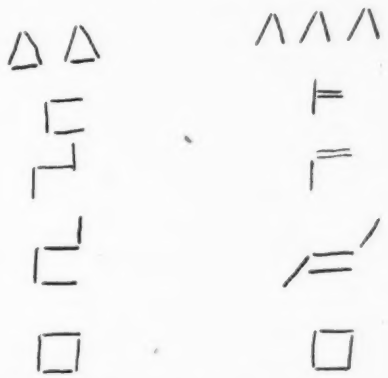

Fig. 9.—The left column of designs represents the patterns; the right, the performance of the patient.

"windows" that fitted the frames were then mingled with inlays that were either too large or too small or were differently shaped (hexagons, octagons, etc.). When asked to pick out the fitting "windows" he performed correctly.

2. *Spatial Orientation in Familiar Surroundings.*—(*a*) Spontaneous Orientation in Space: The patient did not require supervision in his movements at the hospital. He was always able to find and to replace his belongings in their proper places, had no difficulty in moving from room to room or from floor to floor, and superintended his own private affairs in town without assistance. He made use of street cars and elevated trains without difficulty.

(*b*) Directed Orientation in Space: The patient was shown a map of Chicago and was able, on order, to point to the loop, to the Municipal Pier and to the approximate location of the street and house where he lived, and he made no mistake in indicating east, west, south and north.

Comment.—The patient performed fairly well in all the tests for spatial gnosis, except when he was asked to arrange sticks into a figure or to arrange a number of tongue depressors in prescribed groups.

APPERCEPTION

1. *Reproduction of Analytic and Synthetic Data Belonging to the Common Stock of General Knowledge.*—The patient was fairly well able to spell simple words, to indicate the number of syllables even in 4 and 5 syllable words and to name a string of words that begin with A or G, etc.

He gave an adequate account of the difference between various notions (fear and respect) and objects (pen and pencil). The difference given was usually pertinent.

The patient named opposites promptly and correctly for nouns, adjectives, verbs, prepositions, etc. (man, woman; rough, gentle; to run, to sit down).

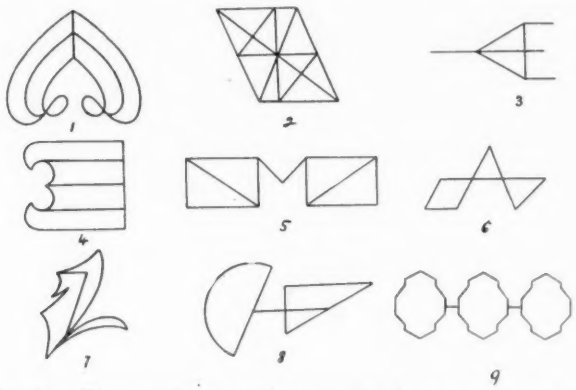

Fig. 10.—Figures shown patient to find letters and numbers.

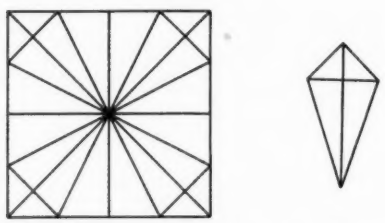

Fig. 11.—The whole object and the part figure.

He enumerated with facility the parts of a whole (genus and species) and the varieties of trees, fruits, birds, colors and religious creeds that he knew.

The patient promptly offered synonyms for policeman (guardian of the law), for pants (trousers) and for automobile (motor car).

2. *Thought Processes Involving Logic and Common Sense.*—(*a*) Logical Inference: He was asked: A fly is an insect. What is a woodpecker? Answer: "A bird." What is a horse? "An animal." What kind of an animal? "One can use for working." He was told: Every human being has 2 legs. I am a human being. Hence, I have 2 legs. He was then told: Every watch shows the time. This is a watch. What follows? He answered: "It tells the time." In various other syllogisms he had no difficulty in finding the conclusion from the premises. He recognized absurdities promptly and corrected them.

(*b*) Psychologic Processes: The patient gave a good detailed description of what he intended to do in order to get the telephone number of a man who owned a restaurant but was not yet listed in the directory. He outlined well in detail how he would go about getting a house built after he had saved $3,000.

3. *Comparison and Abstraction.*—The patient was shown a card with 8 straight and 9 curved lines and was well able to designate them correctly as curved or straight. He was also well able to point out the smaller, larger and largest angles on a card on which were drawn acute, right and obtuse angles of various sizes.

The patient was able to indicate in *9* of figure 10 the 2 Hs; in *8*, the reversed D; in *5*, the M, and in *3*, the E. The 4 in *8* he failed to detect. But the 6, 3 and 7 in *1*, *4* and *7* he found promptly. In all these tasks the question was: Show me an H, E, M, etc., in this figure. He was shown *2* of figure 10 and asked: "Can you find letters in this figure?" He isolated N and V. He was asked to show the part figure in the total figure 11, and did so promptly. All the tests were modifications of those found in Buehler's [17] book.

4. Interpretation of Pictures: The patient described primitive and complex pictures, sometimes synthetically, but as a rule analytically. He often held the picture upside down while describing it, but furnished a fairly competent description of the details.

Comment.—The apperceptive processes were so well within the patient's grasp that they could be safely ruled out as factors responsible for the defect in arithmetical operations.

GENERAL COMMENT

Most authors who have studied acalculia have attempted to reduce the defect to a fundamental inability to handle some spatial element. Lange,[8] after a careful study, even ventured to specify the precise type of spatial element. He said that the errors made by his patient can all be explained on the basis of an inability to manipulate the "category of direction in space." He added that the concepts of quantity and magnitude are "numbers associated with spatial conceptions." The term "category of direction in space" he seemed to identify with the "conceptual and creative structuralization of space" (begriffliche and schoepferische Gliederung in Raume). These terms are quoted verbatim in order to show the vague and indefinite conceptions that have been evoked to interpret the nature of acalculia. On the basis of our material we agree with Lange and others that some sort of spatial element is a conspicuous factor in determining the defect; we also accept the dictum that the concept of direction plays a prominent part in this spatial element; but that the inability to handle this spatial element is solely responsible for acalculia is an assumption unwarranted by our observations. Although in the present study we may have disclosed some new facts, we do not feel justified in claiming that we have established

17. Buehler, K.: Die Gestaltwahrnehmung, Stuttgart, W. Spemann, 1913.

the primacy of any one of the several factors that entered into the causation of the acalculia. The problem at present needs, not the premature elaboration of an intriguing theory, but a refinement of the methods of examination, a further accumulation of case reports or both.

In attempting to analyze our results we shall limit the discussion to functions in which the patient made no or little progress in spite of intensive training. These functions were: addition of numbers the sum of which exceeded 10; subtractions and divisions; tachistoscopic reading; writing; the ability to grasp the meaning of the "position value" of digits; counting of discontinuous quantities; construction of simple figures from small sticks or tongue depressors; constructing numbers from single digits on cards; retention of numbers above 10 within a context; reading the time from a watch; drawing of any kind.

Construction of a Continuous Total from Discontinuous Parts.—It is easy to postulate that all these functions require the facility to construct a continuous total out of discontinuous parts, and to say that the inability so to construct was the sole factor that underlay the defect. This interpretation, however, is not sufficient. The patient was unable to read monosyllabic words tachistoscopically; yet he mastered without difficulty all kinds of words, sentences and paragraphs in plain reading. In plain reading he was required to "construct a continuous (word or sentence) total out of discontinuous (letter) parts," and if the construction disability was at the root of the defect, why did not this inability make itself evident in plain reading? Again, he was unable to construct the total of 77 out of the parts 50 plus 25 plus 2. Why then was he able to construct the total of 77 cents out of the parts one-half dollar, 1 quarter and 2 cents?

Spatial Direction.—Our patient was incapable of maintaining the line of conduction when he constructed the word "bad" out of cards bearing the separate letters b, a, d. Yet, in constructing the number 3,250 out of corresponding single digits, he made mistakes with the "position value" but did not deviate from the line of conduction. In tachistoscopic reading of words he grasped the right letters or the right syllables of a word first; i. e., he reversed the customary direction of reading from left to right. Why then did he read numbers, likewise offered tachistoscopically, from left to right, an observation which we believe has not previously been made? Last [18] and Heidenhain,[19] who used the tachistoscope, did not deal with acalculia. The difference

18. Last, S. L.: Ueber eine Störung der optischen Formauffassung, Monatschr. f. Psychiat. u. Neurol. **76**:238, 1930.

19. Heidenhain, A.: Beitrag zur Kenntnis der Seelenblindheit, Monatschr. f. Psychiat. u. Neurol. **66**:61, 1927.

cannot be explained on the basis of a "body schema" (Schilder [20]), according to which it might be said that the left side of the body did not exist for him (a popular way of expressing this would be by saying "he favored the right side"). It is true that he could not draw a line from right to left, but always drew from left to right. If this was due to a "loss of the left side," why was he not able to pull the bed sheet to the right? Morever, why did he read numbers tachistoscopically from the left? These objections show that the factors of construction and direction, while undoubtedly playing an important rôle, do not explain entirely the essential mechanism of the defect. Some other factor must either be added to or replace the two factors mentioned.

Spontaneity and Automatization.—A striking observation was that a function that was ordinarily beyond the patient's span was nevertheless sometimes correctly exercised when he was unaware of exercising it. He was unable, for example, to solve the problem $9 - 6 = 3$, yet this subtraction was carried out when it was substituted as an answer to the problem $9 + 6 = 3$. Again, he was never able on request to add together 3 digits correctly; yet when the single digits 1, 8 and 3 were called out to him and he was asked to form a number from them he promptly added them together as 12. In other words, identically the same problem was solved under conditions of spontaneity and was almost regularly missed under the conditions of a "task." What then, it may be asked, is the difference between a spontaneous performance and one imposed as a "task"? Wundt [21] called the one "actively intended" and the other "passively experienced" (aktiv gewollt und passiv erlebt). This is a translation rather than an explanation. McLellan and Dewey [22] seem to have had a similar active principle in mind when they stated: "Number represents a certain interest, a certain psychic demand; it is not a bare property of facts." Whether it is called "active intention" or "psychic demand," it is obvious that a certain principle, somewhat in the nature of a special strain, becomes operative in a problem when it is offered as a "task" and becomes proportionately reduced when the same problem is dealt with spontaneously.

This difference between the spontaneous performance and a "task" explains many but not all of the mistakes made by the patient. Under training he mastered the multiplication table but remained inefficient

20. Schilder, P.: Vestibulo-Optik und Körperschema in der Alkoholhalluzinose, Ztschr. f. d. ges. Neurol. u. Psychiat. **128**:784, 1930.

21. Wundt, Wilhelm: Grundzüge der physiologischen Psychologie, Leipzig, Wilhelm Engelmann, 1903, pt. 5, p. 332.

22. McLellan, J. A., and Dewey, J.: The Psychology of Number, New York, D. Appleton and Company, 1895, p. 21.

in analogous additions. In terms of "constructing a total out of its parts" it should be largely immaterial whether the total 42 is to be constructed out of the parts 6 times 7 or the total 13 out of 6 plus 7. As a matter of construction the problems are practically alike. Viewed under the aspect of spontaneity, however, the two problems differ essentially. Multiplications of numbers are much more easily automatized than additions of the corresponding numbers. Whether this greater liability to automatization is an intrinsic quality of the multiplication process or whether it is due to the fact that traditional school training favors repetitive exercises in the multiplication table may be left unargued. The fact is that perhaps under the system of school training the multiplication table has a greater tendency to become automatized than have additive problems.

The fact that our patient was hardly able to count a number of beans in excess of 10 but exhibited a normal facility for mental counting even up to millions points in the same direction. Mental counting is certainly a labored "task" for the early school child, but becomes automatized through uninterrupted practice, while counting of objects is hardly ever taught and hence is not automatized. Again, the addition of one-half dollar, 1 quarter and 2 cents becomes automatized in daily life, whereas this is not true for the addition of 50 plus 25 plus 2.

Additional evidence of the fundamental difference between an automatized performance and an unfamiliar "task" was furnished by the mistakes made in tachistoscopic reading of words. The patient made many mistakes with simple monosyllablic words; but such polysyllabic words as boilermaker, equipment, foreman, Chicago and his own and the physician's name he read promptly. All these words were familiar to him, or automatized; they did not involve a strained "task." Another observation that accentuated the facilitation gained through automatization was: The patient was never able to read monosyllabic nonsense words from the tachistoscope, but was sometimes able to read monosyllabic sense words. While in all these performances the factors of direction and construction play an unmistakable part, the factor of automatization must also be considered. But even these three factors combined are insufficient to explain all the mistakes made by the patient. For example, the difference in the direction of reading numbers and words, respectively, from the tachistoscope cannot be accounted for on that basis.

Analysis and Synthesis.—Another factor that must be given due consideration in the evaluation of the acalculia is the patient's relative proficiency in handling an analytic problem and his relative deficiency in manipulating a synthetic problem. When he was offered words

and numbers to read from the tachistoscope, the task was to grasp a word or a number total, i. e., to synthesize letters into a word and digits into a number; instead, he dismembered the total and failed to synthesize the component parts. For instance, he read "top" as t-o-p or 69 as 6-9. This tendency to grasp parts only was perhaps responsible for his inability to recognize points and to indicate their number when they were offered tachistoscopically. He always designated and drew points as circles and invariably named the wrong number, even when 1 point only was offered. The corresponding numbers of triangles, circles or dashes were read with considerably less difficulty. It may be suggested that the inability to read points and to indicate their number perhaps was due to the fact that a point is the only geometric entity that cannot be decomposed into parts. The patient's general facility for analyzing parts out of wholes, in contradistinction to his inability to synthesize, was convincingly demonstrated by the promptness with which he read the letters M, E, A, etc., and the numbers 4, 7, 6, etc., out of the integrated totals of the figures in figure 10. A similar case of manipulating analytic tasks was apparent when the patient described a 5 as consisting of a vertical bar, a horizontal bar and a semicircle and a 7 as consisting of a horizontal bar and a vertical bar.

Symmetry in Space.—Considerable light was thrown on the principal mechanisms that entered into the patient's defect by his performances in drawing. That he drew relatively best in copying, worse after brief exposure of a pattern and worse yet in drawing to verbal order can be explained by the proportionately decreasing degree of visual facilitation of these tasks. The almost constant deviation to the right emphasized his difficulty in handling the factor of direction; the defective rendering of form, contour and relative size pointed to an inability to construct totals out of parts, each separate stroke of the pencil representing a part of the total drawing. But a striking observation was that his drawing improved in direct proportion to the degree of symmetry of the pattern. Thus, he was helpless in drawing a shoe, failed in designing a ground plan of the examining room and copied the pattern of a church with little regard to the size, form and mutual arrangement of the parts. On the other hand, his performance was fair in drawing a bottle and a house and was almost satisfactory in the sense of construction when he copied or drew on verbal order a box, a table, an apple, a pear, a watch or a human face. In other words, he failed with objects (shoe, ground plan and church) in which the symmetrical element was complex and difficult to trace and performed fairly well with objects which offered good symmetrical orientation (round and quadratic objects).

The factor of symmetry must be given particular weight in the discussion of acalculia. All the elements that have been previously mentioned—direction, construction, analysis and synthesis—are ultimately related to the factor of symmetry. The essential feature of symmetry is either a point or a plane of reference about which the parts of the total are more or less symmetrically or asymmetrically arranged. Construction and direction are both oriented on such a point or plane of reference. Synthesis and analysis are identical with composition and decomposition, and are ultimately guided by relation to a point or plane of reference.

Natorp's Theory of Calculation.—The introduction of the concept of symmetrical or asymmetrical reference offers a possibility to link up the patient's acalculia with the general spatial agnosias that he displayed in all functions that require a grasp of direction, construction, synthesis and analysis. In order to effect this linkage we shall refer to a theory of calculation that was formulated by Natorp [23] in 1910. Since this theory is complex and elaborate, we shall content ourselves with merely outlining it and refer the reader to the original for fuller information. Natorp proceeds from the hypothesis that counting and calculation alike have as their point of departure (point of reference) the zero. Even if one begins to count from 20, 21, 22, etc., he has always in mind the fundamental starting point of zero, and knows that the number 20 is 20 points distant from zero. The universal function of zero is that of a general point of reference. Additions, Natorp continues, are a particular type of counting, a so-called discontinuous count, or a combination of variously counted entities. In order to calculate that 3 plus 2 equals 5, one proceeds from zero and counts 1, 2, 3; then one interrupts the counting process and returns to the zero; now one starts again, counting 1, 2, all the while keeping the first count of 1, 2, 3, in mind. By keeping both counts in mind, one knows that, proceeding from the zero, he has counted first 3, then 2 points or altogether 5. The uniform progression in a forward direction from the zero contains the element of direction; the combination of the separate counts of 3 and 2 and their unification in the act of keeping the counts "in mind" contain the element of the "construction task." The latter requires both a process of keeping the various counts separately (analysis) and the process of keeping them together in mind (synthesis). Thus, the three processes that have been discussed as constituting at least a part of the defect in our patient are actually seen to enter the process of simple addition.

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23. Natorp, Paul: Die logischen Grundlagen der exakten Wissenschaften, Leipzig, B. G. Teubner, 1910, p. 132.

Natorp explained subtractions, multiplications and divisions on the same basis of various processes of counting, proceeding severally from the zero as a point of reference. We do not feel competent to judge the merits of Natorp's theory of calculation, and state merely that we are inclined to agree with his thesis. If the theory is correct it offers a fairly satisfactory basis for explaining on a common ground most but certainly not all of the patient's defective performances, both in calculation and in the other functions he was incapable of exercising. One common ground on which these functions meet is the inability to proceed from a given point of reference and to remain focused on it, progressing with the task of construction.

SUMMARY AND CONCLUSIONS

1. As a result of carbon monoxide poisoning, a patient developed a condition the main residual symptoms of which were acalculia and agraphia.

2. The main factors that seemed to enter into the causation of the acalculia were: difficulty of constructing a continuous total out of discontinuous parts, difficulty of following a given direction from a given point of departure and difficulty of grasping a whole without decomposing it into its parts.

3. These spatial and construction elements alone, however, do not account for the defects without taking into account the additional elements of the "task" and of symmetry. Even then it is impossible to explain all the defects observed.

4. Natorp's theory of calculation offers some but not an entirely satisfactory explanation of the nature of the defects.

5. The need for a refinement of testing methods and for an accumulation of case reports is stressed.

ABSTRACT OF DISCUSSION

DR. PAUL SCHILDER, New York: This paper has demonstrated one type of acalculia, which I should like to call the optic type. One is often able to demonstrate agnosic difficulties with the tachistoscope when one cannot demonstrate them with other methods. But I wish to draw attention to the fact that it is only one of the possible types of acalculia. There is another type of acalculia which is combined with finger agnosia and with agraphia, and that is a different as well as an important type, especially since it is known that its localization is more toward the parietal region, whereas the type demonstrated is a purely optic type.

In every case of acalculia one should be especially interested in the way the patient writes, because in that way one will determine whether there is finger agnosia or agraphia also.

DR. E. D. FRIEDMAN, New York: Recently, we had occasion to observe a patient at Bellevue Hospital who attempted suicide with illuminating gas and who, on emerging from his stupor, exhibited an agnosia in the auditory sphere. He presented a type of word deafness similar to that encountered in advanced lesions of the temporal lobe. In this case it was assumed that there were bilateral lesions in the cortex with resulting auditory agnosia.

DR. DONALD GREGG, Wellesley, Mass.: Was Dr. Singer's case complicated by any previous astigmatism? The tilt of the figures reminds me of the tilt and elongation of the figures in the paintings of El Greco, the artist, who is believed to have been handicapped by severe astigmatism.

DR. H. DOUGLAS SINGER: In answer to Dr. Gregg, I cannot say whether the patient had astigmatism or not. He never wore glasses.

I do not agree that this is a case of agnosia. In my opinion it is one of apraxia. General apraxia was marked when I first saw the patient but that rather rapidly disappeared under training. He probably did have finger agnosia at the start; he said that it was two or three months before he was able to know which fingers he was dealing with, or what he was doing with them; but at the time we studied him, there was no evidence of finger agnosia. The patient also had a complete agraphia at first. He learned to write, however, but there are still many disturbances in writing, which are reported in the paper.

ABOLITION OF BULBOCAPNINE CATATONIA BY COCAINE

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The discovery that a catatonic condition closely resembling that seen in man can be produced consistently in animals by the injection of bulbocapnine has made possible an experimental study of this interesting phenomenon. From the clinical point of view, the chief objective, of course, has been to determine by what means the catatonia can be reduced or eliminated, with the hope that information obtained from animals may be of therapeutic significance for man.

Study of the effects produced by various agents on bulbocapnine catalepsy has been facilitated recently by the development of a method by which this condition can be measured in adult monkeys (Richter and Paterson [1]). These animals under the influence of bulbocapnine will grasp a horizontal bar and hang freely by one hand for varying lengths of time. Normally, they cannot be made to hang at all. If the grasping response is tested at frequent intervals after the injection of the drug, graphs are obtained showing the onset, maximum height and total duration of the effect. Such graphic records make possible a quantitative study of the catatonic condition and help to correct and amplify observations made by simple inspection.

The effects produced by hyoscine and by carbon dioxide on bulbocapnine catalepsy have already been studied according to this method (Paterson and Richter [2]). These studies have shown that hyoscine greatly prolongs the interval during which the stupor is present and during which the hanging response can be elicited. The effect of high concentrations of carbon dioxide on the hanging response is similar to that of hyoscine, though not so marked. Carbon dioxide, however, first produces a brief but definite respite from the stuporous symptoms, so that the animals behave in a normal manner for a few minutes.

From the Psychobiological Laboratory, Henry Phipps Psychiatric Clinic, Johns Hopkins Hospital.

1. Paterson, A. S., and Richter, C. P.: J. Pharmacol. & Exper. Therap. **43**:677, 1931.

2. Paterson, A. S., and Richter, C. P.: The Action of Hyoscine and Carbon Monoxide on Bulbocapnine Catalepsy, Arch. Neurol. & Psychiat. **29**:231 (Feb.) 1933.

The same methods have been applied in the present experiments to investigate the effect of cocaine on bulbocapnine catatonia.

METHODS

The experiments were conducted on four Macacus rhesus and four Macacus sinicus (pithecus) monkeys. As these animals show individual variations in their responses to bulbocapnine, the same dose of this drug was injected into each of them on several occasions, and the resulting symptom complex was recorded and studied. A graphic chart of the hanging response was made each time, and the experiments were repeated until a fairly characteristic curve had been established for each monkey.

Bulbocapnine was given in doses of 50 mg. for the adult animal. Cocaine hydrochloride, in doses of from 8 to 26 mg. (from 2 to 5 mg. per kilogram of body weight) was administered subcutaneously at various intervals before and after the injection of bulbocapnine. Throughout the experiment the general symptoms were noted, and the hanging response was measured.

The method of eliciting and recording the hanging reflex has been presented in detail by Richter and Paterson.[1] Briefly, it may be described as follows: The monkey, whose extremities are bound so that only one hand is free, is lifted by its head and its free hand is brought into contact with a horizontal bar. The animal under the influence of bulbocapnine grasps the bar firmly and hangs for a considerable time. The hanging time is recorded on a stop-watch.

RESULTS

Cocaine always either greatly reduces the effect of bulbocapnine or abolishes it altogether. The hanging records demonstrate this fact strikingly. Several graphs from one animal are presented in chart 1. For purposes of comparison, the first chart (chart 1 *A*) shows the hanging record when bulbocapnine alone was given. It can be seen that twenty-two minutes after the injection of 50 mg. of bulbocapnine the monkey hung for forty-two and thirty-five seconds by its right hand and left hand, respectively. From then on the hanging response grew gradually weaker, finally disappearing one hundred and eighteen minutes after the injection of the drug. It may be noted that the symptoms of catatonia appeared as usual about the time the animal began to hang, and disappeared simultaneously with the disappearance of the hanging response. During the time of maximal hanging, the animal was most catatonic, showing excessive salivation, catalepsy and almost complete unresponsiveness.

Chart 1 *B* shows the effect produced on the same animal by the injection of 16 mg. of cocaine, fifteen minutes after the administration of bulbocapnine, when the hanging response and the other catatonic symptoms were clearly present. The hanging time showed a sharp drop to one second, six minutes after the injection of cocaine, and the curve remained on this low level until the disappearance of the response, seventy-eight minutes later. Soon after the cocaine was given, the

animal recovered from the catatonic condition, becoming responsive and active, and making well coordinated attempts to escape; it showed no further tendency to return to the stuporous state.

When cocaine was injected before the bulbocapnine, the results were even more striking, as may be seen in chart 1 *C*, obtained from the same animal. A dose of 16 mg. of cocaine was given fifteen minutes before the usual 50 mg. of bulbocapnine. With the two injections in this time relationship, the hanging response was almost completely

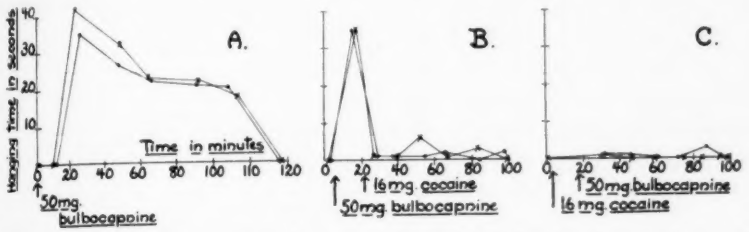

Chart 1.—*A*, hanging curves for the right and left hands of a monkey under the influence of 50 mg. of bulbocapnine. *B*, curve for same animal, showing how cocaine almost totally abolishes the bulbocapnine hanging response. The cocaine was given fifteen minutes after the injection of bulbocapnine. *C*, curve for same animal, showing the failure of the bulbocapnine hanging response to appear when cocaine is injected some time before the bulbocapnine.

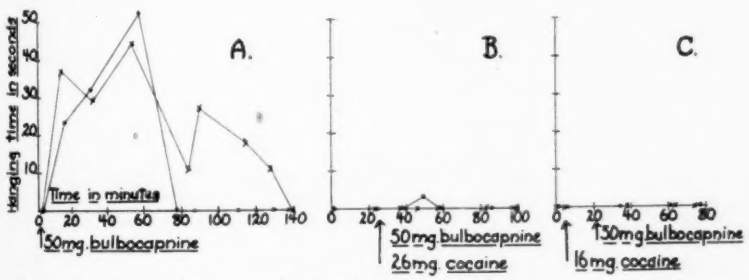

Chart 2.—*A*, another animal, showing the hanging response brought out by 50 mg. of bulbocapnine. In this animal the right and left hands were not equally affected. *B*, same animal, showing the practical absence of the bulbocapnine hanging response when cocaine is injected simultaneously with the bulbocapnine. *C*, same animal, showing the complete absence of the bulbocapnine hanging response when cocaine is injected fifteen minutes before the bulbocapnine.

eliminated, being present for only one second on two occasions, thirteen and sixty-seven minutes after the injection of bulbocapnine. The animal did not show any abnormal behavior or catatonic symptoms at any time during the later period of observation.

Similar records obtained from another animal are presented in chart 2, *A*, *B* and *C*. The first graph, showing the effect of bulbocapnine alone, is somewhat unusual, but typical for this animal, in that it shows

a long duration of the response on one hand, one hundred and thirty-nine minutes, and a great irregularity. The longest hanging time for any one test was reached after fifty minutes, when the animal hung for fifty-two and forty-four seconds from its right and left hands, respectively.

Chart 2*B* was obtained when cocaine (26 mg.) was injected simultaneously with the bulbocapnine. Under these circumstances, the grasping response failed to appear, except for one test, when the animal hung for three seconds. Aside from this, the normal behavior pattern was in no way altered by the drugs.

In another experiment recorded in chart 2 *C*, the cocaine was injected eighteen minutes before the bulbocapnine. Again the animal remained perfectly normal. The hanging response was not present at any time, and the usual catatonic symptoms failed entirely to appear.

Essentially the same results were obtained in all of the thirty-six experiments, seventeen in which cocaine was given after the bulbocapnine and nineteen in which it was given before. It is thus clearly demonstrated that the catatonic condition produced in monkeys by bulbocapnine can be successfully counteracted and abolished by cocaine. When the cocaine is given before the bulbocapnine, the catatonic symptoms do not appear. When it is given at the height of the bulbocapnine effect, they disappear almost at once. Furthermore, there is no tendency, as there is with carbon dioxide, for the animals to return after a few minutes to the catatonic state. The interruption is complete and permanent.

COMMENT

The evidence at hand does not allow any definite conclusions regarding the site of action of either bulbocapnine or cocaine. The fact that the hanging response may be elicited in monkeys by lesions of the premotor cortex, area 6 of Brodmann (unpublished results by Richter and Hines), suggests that this part of the brain may possibly be thrown out of function by the bulbocapnine. Cocaine then would counteract the inhibiting effect of this point. There is evidence, however, which indicates that both bulbocapnine and cocaine have a definite action on subcortical centers as well. Solution of this part of the problem must wait for further facts.

These results naturally suggest consideration of the efficacy of cocaine in treating catatonic conditions in man. A review of the literature reveals that cocaine has been used in cases of catatonia by several workers, particularly Berger,[3] Fleck,[4] Bychowski,[5] Jacobi[6] and

3. Berger, H.: Ztschr. f. d. ges. Neurol. u. Psychiat. **24**:86, 1921.
4. Fleck, U.: Ztschr. f. d. ges. Neurol. u. Psychiat. **92**:84, 1924.
5. Bychowski, G.: Monatschr. f. Psychiat. u. Neurol. **58**:329, 1925.
6. Jacobi, A.: Arch. f. Psychiat. **79**:383, 1927.

Moser.[7] Berger has reported a lifting of the stuporous state in eight of eleven patients for a period of from one to eight hours. Similar observations made by Fleck and Bychowski indicate that their patients actually showed a contact with their surroundings very similar to that following inhalations of carbon dioxide-oxygen as reported by Loevenhart, Lorenz and Waters.[8]

It is possible that with a more adequate knowledge regarding the dosage of cocaine, as well as the optimal number of administrations and frequency of repetition, prolonged interruption of the catatonic manifestations may also be obtained in man.[9]

SUMMARY

1. Experimental catatonia produced by bulbocapnine in monkeys is eliminated by injections of cocaine. The animals behave normally almost at once and do not return to the stuporous condition.

2. Cocaine injected before bulbocapnine prevents the appearance of the catatonic syndrome.

3. The hanging response which appears in Macacus rhesus monkeys when they are under the influence of the bulbocapnine is eliminated by cocaine. Objective records were thus obtained of the effect produced by cocaine on bulbocapnine catatonia.

4. The results suggest that cocaine should prove of value in the treatment of catatonic symptoms in man.

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7. Moser: Arch. f. Psychiat. **66**:715, 1922.

8. Loevenhart, A. S.; Lorenz, W. F., and Waters, R. M.: Cerebral Stimulation, J. A. M. A. **92**:880 (March 16) 1929.

9. At the time that this paper was ready for publication, a reprint of a paper was received from Evrard and Spiegel (Ztschr. f. d. ges. Neurol. u. Psychiat. **138**:197, 1932) describing similar experiments on cats. The effects produced on the bulbocapnine stupor by cocaine were less definite and consistent than in the monkeys, and were somewhat complicated by other accompanying symptoms. This is due in part to the fact that cats are normally very quiet and their limited overt behavior does not contrast strongly with the stuporous state; on the other hand, monkeys are normally very lively, with a wide range of overt activities which form a strong contrast to the stupor.

TREATMENT OF ATHETOSIS AND DYSTONIA BY SECTION OF EXTRAPYRAMIDAL MOTOR TRACTS

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There is perhaps no group of diseases more distressing to patient, relatives and physicians than that characterized by constantly recurring involuntary abnormal movements—the dyskinetic or amyostatic syndrome, in which are included the major choreas, athetosis, torticollis and the dystonias. Though the incidence of these diseases is not high, many of them are chronic.

Knowledge of the pathology, physiology and clinical classification of the amyostatic diseases leaves much to be desired. An extensive clinical study by means of motion pictures has recently been published by Herz,[1] and a detailed review of the literature on the pathology by Spatz.[2] Nothing is added to these aspects of the subject by the cases here reported. To account for the abnormal movements on a physiologic basis, several different theories have been proposed: 1. The abnormal movements are due to impulses coming down over the pyramidal pathways either as a result of direct irritation (Kahler and Pick,[3] von Monakow [4]) or as the result of an abnormal stimulus arising in the cerebellum (Bonhoeffer [5]) or striatum (Wilson [6]). 2. The movements are due to impulses coming over one of the extrapyramidal motor tracts (Anton [7]) as the result of a release of inhibition from the

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From the Neurological Unit, Boston City Hospital.

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1. Herz, E.: Die amyostatischen Unruheerscheinungen: Klinische-Kinematographische Analyse ihrer Kennzeichen und Begleiterscheinungen, J. f. Psychol. u. Neurol. **43**:3, 1931.

2. Spatz, H.: Physiologie und Pathologie der Stammganglien, in Bethe, A., et al.: Handbuch der normalen und pathologischen Physiologie, Berlin, Julius Springer, 1929, vol. 10, p. 318.

3. Kahler and Pick: Ueber die Localisation der posthemiplegischen Bewegungserscheinungen, Vrtljschr. f. d. prakt. Heilk. **2**:31, 1879.

4. von Monakow, C.: Gehirnpathologie, in Nothnagel: Spezielle Pathologie und Therapie, ed. 1, Vienna, Alfred Hölder, 1897, vol. 9, pt. 1, p. 329.

5. Bonhoeffer, K.: Ein Beitrag zur Localization der choreatischen Bewegungen, Monatschr. f. Psychiat. u. Neurol. **1**:6, 1897.

6. Wilson, S.: Disorders of Motility and of Muscle Tone, with Special Reference to the Corpus Striatum: IV. Athetosis, Lancet **2**:216, 1925.

7. Anton, G.: Ueber die Betheiligung der grossen basalen Gehirnganglien bei Bewegungsstörungen und insbesondere bei Chorea, Jahrb. f. Psychiat. u. Neurol. **14**:141, 1896.

cerebellum (Kleist[8]), from the striatum (C. and O. Vogt[9]) or from some other of the higher extrapyramidal centers (Foerster[10] and Jakob[11]). 3. They are due to irritation of motor centers in the striatum (C. and O. Vogt[9]).

The problem of which of these theories to accept became an acute and practical one with the admission of a young patient suffering from dystonia to the Neurological Unit of the Boston City Hospital.

REPORT OF CASES

Case 1.—Harriet H., aged 14, a patient of Dr. J. L. Rudd, was admitted on March 2, 1931, on the recommendation of Dr. Jacob Kasanin. She is the third child of healthy parents. The two older children are well, but a fourth has a similar disease (case 4). Another younger sister died at the age of 6 months of unknown cause. Otherwise no similar diseases are known to have occurred in the family. The patient's birth was normal. She walked at the age of 18 months, but was slow in all her movements. She had difficulty in walking, dragged the right leg and kept the foot everted. She went for a long time to another hospital for muscle training by expert hands without appreciable benefit. At the age of 7, she found it difficult to hold anything in the right hand because of inability to extend the fingers. She graduated from grammar school at the age of 12, however. About this time she began to complain of a pulling sensation in the right thigh.

The patient and her sister were shown before the Boston Society of Psychiatry and Neurology on Nov. 30, 1930, by Dr. Kasanin.[12] The patient was growing rapidly worse. Her neck and all four extremities were the seat of intermittent spasms, mainly flexor in type. These were worst in the right leg, which would be drawn up on the abdomen so tightly that it could not be pulled down until the end of the spasm, which lasted from ten to twenty seconds. She was unable to walk. Her speech, never plain, became almost unintelligible. Phrases were delivered in intermittent explosions and in a "palatal" tone. Dr. Kasanin's diagnosis of atypical dystonia musculorum deformans was generally concurred in, though the possibility of hepatolenticular degeneration was suggested. During the next two months the patient's condition grew steadily worse. The contractions of the thigh became painful and so frequent that she was unable to sit up.

Examination.—The patient was in good general condition. The liver was not palpable. Routine laboratory tests gave negative results.

Neurologic Examination.—There were a high grade myopia and myopic cup on both sides. A white area, apparently due to retinal atrophy, was seen to the nasal

8. Kleist, K.: Die psychomotorischen Störungen und ihr Verhältnis zu den Motilitätstörungen bei Erkrankungen der Stammganglien, Monatschr. f. Psychiat. u. Neurol. **52**:254, 1922.

9. Vogt, C., and Vogt, O.: Zur Lehre der Erkrankungen des striären Systems, J. f. Psychol. u. Neurol. **25**:631, 1920.

10. Foerster, O.: Zur Analyse und Pathophysiologie der striären Bewegungsstörungen, Ztschr. f. d. ges. Neurol. u. Psychiat. **73**:1, 1921.

11. Jakob, A.: Die extrapyramidalen Erkrankungen, Berlin, Julius Springer, 1923.

12. Kasanin, J., and Allen, S. C.: Dystonia Musculorum Deformans in Siblings, Arch. Neurol. & Psychiat. **25**:1166 (May) 1931.

side of the left disk. The patient could not cooperate for examination of the visual fields. There were a slight bilateral ptosis and a little nystagmus in both directions. The facial muscles and those concerned with speech shared in the recurrent spasms, but no other abnormalities were made out in the cranial nerves.

Between spasms, all deep reflexes could be elicited and were bilaterally equal and within normal limits. The abdominal reflexes were present. The Babinski and Oppenheim reflexes were absent. No incoordination (so far as this could be tested) and no sensory disturbances were present. Except for the contractures of the fingers of both hands around the thumb and a slight flexion of the right knee, the patient had good control and strength in all extremities between the spasms. Involuntary contractions occurred at intervals of from thirty to sixty seconds, and lasted from fifteen seconds to four minutes. Usually, the right knee was flexed on the chest, both wrists were flexed and the neck was hyperextended. At the height of contraction the patient would cry out with pain (fig. 1). Effort, sensory stimulation, or the slightest excitement increased the spasms. The patient was

Fig. 1 (case 1).—Patient at the height of an attack before operation.

therefore entirely unable to care for herself. When she was entirely isolated and quiet, however, there would be intervals when she was free from attacks.

The injection of 1 cc. of harmine relieved the spasms for eight hours. The patient felt weak, nauseated and uncomfortable, however, during this time.

Comment.—Some permanent relief was urgently needed. Reeducation is sometimes of benefit in such cases, but had proved unavailing in the present one. Horsley,[13] in 1908, excised a portion of the motor cortex in a patient suffering from athetosis in one hand, with relief for fifteen months. I am informed, however, that the athetosis subsequently returned, and this has been Foerster's experience.[10] Moreover, such an operation is out of the question when the entire body is

13. Horsley, V.: The Function of the So-Called Motor Area of the Brain, Brit. M. J. **2**:125, 1909.

involved. Section of the posterior roots is now an accepted treatment for spasmodic torticollis, and Winslow and Spear [14] reported the cessation of athetoid movements (indeed, for a time all movements) in one leg after deafferentation. But the operation has proved unavailing in the hands of Frazier [15] and Foerster.[16] Foerster also divided the anterolateral tract for paralysis agitans [16] without success. Puusepp [17] incised the column of Burdach for postencephalitic paralysis agitans of one arm, with some relief of tremor but not of rigidity. Foerster also mentioned the possibility of section of the anterior roots, but such a procedure seemed scarcely justified under the circumstances.

In this case, there was evidence that the pyramidal tracts were intact. The periodicity and pattern of the spasms suggested that they were the result of impulses arising in the basal ganglia and carried down the cord over the extrapyramidal motor pathways. Accordingly, the proposal was made to cut the extrapyramidal tracts above the brachial plexus. This suggestion, I later learned, had already been made by Spiegel,[18] in 1924, for the relief of spasticity. The unfortunate patient was in such a miserable condition that she and her family did not hesitate long to grasp at any possibility of even temporary relief, no matter what the cost. It was understood by all concerned that the condition was degenerative and progressive.

The next problem was the location and accessibility of the tracts within the cord. Two illustrations are available in the literature—unfortunately both are rather unsatisfactory—of descending degenerations in the cervical cord following complete transverse lesions (fig. 2 *A* and *B*). Subtracting from the degenerated areas the familiar shape of the crossed and direct pyramidal tracts and the ground bundle, there remain two general groups of fibers which are by definition *extrapyramidal descending tracts*. One lies just anterior to the crossed pyramidal tract, and extends mesially as far as the gray matter. The other lies along the periphery of the cord in the anterior quadrant. The origin of these descending fibers is not satisfactorily

14. Winslow, R., and Spear, I. J.: Section of Posterior Spinal Nerve Roots for Relief of Gastric Crises and Athetoid and Choreiform Movements, J. A. M. A. **58**:238 (Jan. 27) 1912.

15. Frazier, C.: Surgery of the Spinal Cord, New York, D. Appleton and Company, 1918, p. 668.

16. Foerster, O.: Schlaffe und spastische Lähmung, in Bethe, A., et al.: Handbuch der normalen und pathologischen Physiologie, Berlin, Julius Springer, 1929, vol. 10, p. 922.

17. Puusepp, L.: Cordotomia Posterior Lateralis (Fasc. Burdachi) on Account of Trembling and Hypertonia of the Muscles in the Hand, Folia neuropath. estoniana **10**:62, 1930.

18. Spiegel, E.: Experimentelle Untersuchungen über die operative Beeinflussbarkeit des Muskeltonus, Jahrb. f. Psychiat. u. Neurol. **43**:165, 1924.

established from cases in human beings. One can probably best identify them from Papez'[19] careful work on cats (fig. 2 *C*).

Experimental evidence in regard to the results of cutting extrapyramidal motor tracts is somewhat contradictory. On the one hand, Spiegel showed that section of the anterolateral (chiefly reticulospinal) tract decreased tone in an otherwise intact animal,[18] and Kuré and his co-workers[20] showed a similar relaxation in the decerberate animal following section of the rubrospinal tract at Forel's decussation. Destruction of the direct vestibulospinal tract in the brain stem pro-

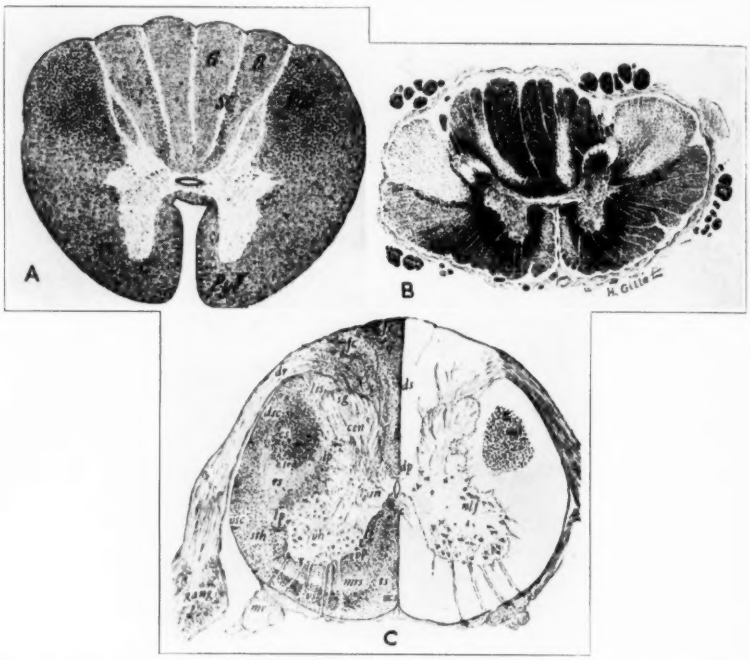

Fig. 2.—*A*, cross-section of the lower cervical cord below a transverse lesion. Marchi stain. (After Obersteiner: Anleitung beim Studium des Baues der nervöse Zentralorgane im gesunden und kranken Zustände, Vienna, Franz Deuticke, 1912, p. 342.) *B*, degeneration of the cord below a high cervical tuberculoma. Pal stain. (After André-Thomas, Touche and Lortat-Jacob: Rev. neurol., 1901, p. 708. *C*, a transverse section of the seventh cervical segment of the cord of a cat, showing the position of various tracts: *rs*, rubrospinal; *mrs*, medial reticulospinal; *vs*, vestibulospinal, and *ts*, tectospinal. Marchi method; reduced from × 12. (After Papez: Comparative Neurology, New York, Thomas Y. Crowell Company, 1929.)

19. Papez, J.: Comparative Neurology, New York, Thomas Y. Crowell Company, 1929.

20. Kuré, K.; Shinosaki, T.; Nagano, T., and Imagawa, T.: Ueber die Enthirnungsstarre, Ztschr. f. d. ges. exper. Med. **45**:296, 1925.

duced atonia in Gray's cats.[21] On the other hand, Rademaker [22] has built up an elaborate body of evidence to show that lesions of the rubrospinal tracts lead to spasticity, and Gray [21] found hypertonia as a result of lesions of the crossed vestibulospinal tract. Perhaps the most reassuring consideration was that anterolateral chordotomy for the relief of pain in man seldom leads to serious motor loss, though performed in the region of the extrapyramidal tracts.

Operation.—This was undertaken on March 27, 1931, under tribromethyl alcohol and procaine hydrochloride anesthesia. The laminae of the fourth and fifth cervical vertebrae were removed and the dura was opened both longitudinally and transversely at the fifth spinal segment. The dentate ligament was severed on the right, and by means of its attached stump the cord was rotated until the anterior spinal artery came into view. An incision, about 2 mm. deep, was made in the anterior surface of the cord. A second stab wound was then made with a sharp pointed knife, about 4 mm. deep and 3 mm. across, extending toward the central canal from the origin of the dentate ligament.

Similar incisions were made on the left. Although little blood had been lost, the patient's blood pressure fell rather suddenly, and she remained in profound shock for several hours. The wound was closed in the usual manner.

Course.—On the day following the operation, the general condition was poor. The blood pressure remained low. The patient vomited almost everything given to her. She had weakness of all extremities and retention of urine. There was complete anesthesia for pain (but not for touch) up to the shoulders. The abnormal movements, however, were completely relieved.

The patient slowly improved; two weeks after the operation she had regained control over the bladder and had begun to move the extremities. The hypalgesia gradually disappeared entirely. On discharge, on April 14, she was able to use the right hand in feeding herself; she also had some control over the left hand. The legs could be moved, but were extremely weak. There was a slight ankle clonus on the left, but no Babinski sign. The deep reflexes were all lively but feeble. There was a peculiar pink flush all over the body, and vasomotor reflexes were unusually active. She continued to have spasms (occasionally painful) in the neck and face, and speech was not improved, but the spasms disappeared completely from the remainder of the body.

The patient was seen again in October. She had made steady improvement. She was able to stand and to take a few steps with assistance (fig. 3 *B*). She could drink when a glass was placed in her hand, and write, though painfully and poorly (fig. 3 *C*). She was much more cheerful and happy than before the operation; indeed she seemed somewhat euphoric.

In February, 1932, she was distinctly worse again in general. The contractions of the neck muscles were more painful. Talking was more difficult and she had grown more apathetic. The limbs tended to remain in a flexed condition, and a few athetoid movements were noticed in the toes of the right foot. At the time

21. Gray, L.: Some Experimental Evidence on the Connections of the Vestibular Mechanism in the Cat, J. Comp. Neurol. **41**:319, 1926.

22. Rademaker, G.: Die Bedeutung der roten Kerne und des übrigen Mittelhirns für Muskeltonus, Körperstellung und Labyrinthreflexe, Berlin, Julius Springer, 1926.

of this admission, it was observed that the deep reflexes of the legs had become much increased, and that there was an inexhaustible clonus on both sides. The Babinski sign was questionable.

The patient was readmitted on May 19, 1932, at the request of her family, on account of increased dystonic movements of the neck, exactly simulating spasmodic torticollis. In addition, the fingers had acquired a fixed contracture, so that they could not be extended passively even by the use of considerable force.

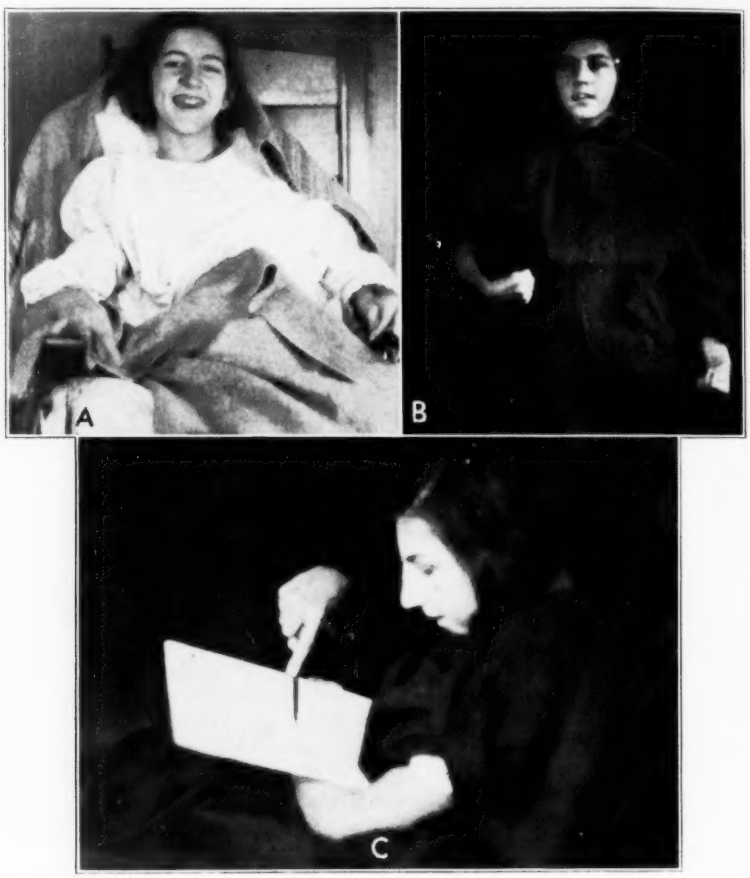

Fig. 3 (case 1).—*A*, patient sitting up without assistance, two weeks after operation. *B*, patient standing alone, five months after operation. *C*, patient writing.

Second Operation.—This was undertaken on May 19. The old wound was reopened and the anterior columns were incised, to a depth of about 3 mm., as high in the cord as was possible—on both sides between the first and second cervical segments. There was a slight rise in the respiratory rate and a fall of blood pressure.

Course.—The patient made a good operative recovery and the spasm of the fingers was relaxed. The movements of the neck were unabated, however, and the fingers gradually became clenched once more in the course of two weeks.

Third Operation.—To alleviate the distressing torticollis, the wound was reopened for the third time on June 10. On this occasion, Dr. Hallowell Davis and Dr. Leon Saul were present, and under their direction action-currents were taken off from various parts of the brain stem. The details of this procedure will be reserved for another communication, but the only point that is pertinent to the present subject is that rhythmic discharges, synchronous with the patient's contractions, could be obtained from the anterior columns above the level of incision but not from the lateral columns. No further operative procedures were carried out on the cord itself, but the first four anterior roots and the accessible roots of the eleventh cranial nerve were crushed on both sides.

Course.—The patient was largely relieved of the torticollis by this procedure, although occasional spasms persisted in the sternomastoids and trapezii. The neck was very weak, however, and she was subject to attacks of tachypnea. The general condition continued to grow worse and she was having frequent periods of coma at the time of her discharge on June 22. She died of bronchopneumonia on July 25, 1932.

Autopsy.—Aside from the operative scars, no significant gross lesions were found. Microscopic study of the specimens is in progress.

Comment.—The operation in this case left the patient still in a pitiably helpless state and did not stay the progress of the disease. However, a comparison between her state before and that after the operation has left no question in the mind of any one concerned that the procedure had been justified.

The second case appeared more suitable for this operation, as the lesion was apparently fixed, there having been no progression or increase of symptoms.

Case 2.—Tommy W., aged 12, a patient of Dr. Samuel Levine, was admitted to the Neurological Unit on June 8, 1931, on the recommendation of Dr. Bronson Crothers. The patient was the second child of healthy parents of Irish stock, and three siblings were healthy. His birth was precipitate, but the attending physician could find no evidence of injury. He sat up and moved about normally until the age of 7 months, when he had a severe attack of "influenza" which lasted four weeks. From this time on the patient was unable to sit or stand and had suffered from attacks of rigidity affecting all the extremities, the neck and the face. At the age of about 1 year, he was admitted to the Children's Hospital, and since then has received muscle training at frequent intervals, which was of help in correcting the position of the head but did not relieve the generalized spasms. When he learned to talk, his speech was as ill controlled and explosive as the other muscular movements.

In spite of the patient's helplessness and difficulty in speech, he had made excellent progress under special teachers, and was a well informed, intelligent, good natured boy. He did fifth and sixth grade work. The spasms were much less intense when the patient was in familiar surroundings and among friends.

Examination.—This was difficult, owing to generalized spasms which recurred at frequent irregular intervals. They were so severe and constant that he was almost always perspiring and out of breath. He was a heavy, well developed boy. General physical examination and the usual laboratory tests, including lumbar puncture, revealed no abnormalities.

The optic disks were normal. There was a slight nystagmus. The other cranial nerves were not remarkable. Deep reflexes were elicited with great difficulty owing to the rigidity. There was a suggestion of ankle clonus on both sides, with a positive Babinski sign. No sensory disturbances were detected. Coordination was impossible to test.

The almost constant spasm followed no definite pattern. In general, the head and eyes were drawn to the left. The extremities were thrown about in grotesque positions, so that there was danger in standing within the range of his arms. The parents stated, however, that between spasms he could occasionally perform simple

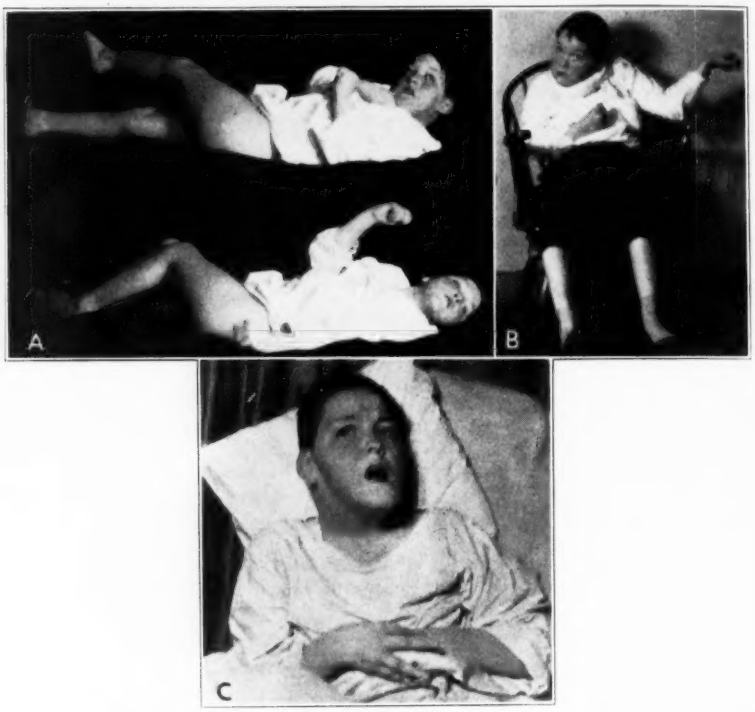

Fig. 4 (case 2).—*A*, patient before operation, in two successive athetoid positions. *B*, patient sitting in a chair four months after operation. Note the persistent spasms in the neck and left shoulder. *C*, patient one month after second operation.

movements, such as picking up an object from the table with strength and accuracy. He was unable to sit up, to stand, to feed himself or to write.

The injection of harmine had no effect on the spasms. An encephalogram revealed no abnormalities.

Operation.—When the outlook was explained to the patient and his parents, they were all eager for an operation. This was performed June 28, 1931, under tribromethyl alcohol and procaine hydrochloride anesthesia. Great difficulty was encountered in getting the patient into a proper position, because of persistent spasms. The fourth and fifth cervical segments were exposed. Incisions were made along the surface of the anterior quadrant, about 2 mm. deep, and just

anterior to the pyramidal tract, about 4 mm. deep, as in the previous case. The incision was made at the level of the fifth segment on the left and the fourth segment on the right. The wound was closed in the usual manner, and the patient left the table in good condition.

Course.—The patient made a good postoperative recovery, but complained of headache. He was incontinent for about two weeks. Two days after the operation, he was able to close both hands and toes. Movements of the left hand caused flexion of the forearm, however. Deep reflexes were absent, and there was still a bilateral Babinski sign. Sensation was not affected. There were no abnormal movements below the level of the operation.

On discharge, on July 28, the patient was having spasm of the eyes, face, neck and left shoulder as before. Speech was unchanged. Occasional slight involuntary movements occurred in the right hand and both feet, but he was able to sit up in a chair (with head supported by a collar) and to move the right arm voluntarily to some extent. Clonus and the Babinski sign persisted.

He was seen again on Oct. 15, 1931. He was then able to sit up in a chair and to turn the pages of a book. More delicate movements, such as drinking, eating and writing, were impossible. The left arm was held abducted and flexed; the head was drawn to the left, and there was a slight inconstant contraction of the muscles of all extremities, except the right leg (fig. 4 *B*); this, however, was not sufficient to cause an actual movement. The family felt that being able to sit up and to lie in bed without danger of throwing himself out was a great advance for him.

The patient was seen again on May 12, 1932. The parents felt that he had continued to improve. The spasms of the neck and face continued unabated, but the contractions of the left deltoid and biceps no longer caused elevation of the left arm and forearm. There were some involuntary movements of all four extremities, but they were not sufficient to prevent his sitting in a chair. A change that the parents noted was the cessation of the previously almost constant perspiration and fatigue. Muscle training was now much easier to carry out.

The movements of the neck closely resembled those of "idiopathic" spasmodic torticollis. The deep reflexes were exaggerated, and there was a bilateral Babinski sign but no clonus.

Second Admission.—The patient was readmitted on June 27, 1932, for relief of the spasms of the neck. He was able to make feeble movements of the legs; occasional mild spasms appeared in them. The arms were stronger but more spastic. In general, however, the condition was far more comfortable than before the first operation.

Second Operation.—The old wound was reopened on June 28, and the foramen magnum was enlarged. With Dr. Saul's amplifier it was possible to obtain intermittent action currents from the spinal accessory nerves, but some trouble developed in the amplifier before any could be led off from the cord itself. The lower roots of both accessory nerves and the anterior roots of the first three cervicals were crushed, and incisions were made in the anterior columns just below the first anterior roots. There was a sharp rise in the respiratory rate at this point (to 60 per minute). Some difficulty was experienced in closing the wound owing to the scar of the previous operation.

Course.—The patient was greatly relieved. The spasms in the face persisted, but phonation was distinctly improved. The neck was weak and had to be supported by a collar at first, but only minor twitchings occurred. The fingers were relaxed and the patient began to do simple exercises and games for the first time in his life. The legs were free from spasm. There was no change in the reflexes from their preoperative condition.

Comment.—In this case, also, the patient's final condition was unhappy, but there was a great improvement over that existing before the two operations.

From these two experiences, it seemed justifiable to conclude that section of the extrapyramidal tracts could be undertaken without grave danger, that its chief or sole influence was exerted on the homolateral extremities, and that hyperkinesia and rigidity of two different types could be favorably influenced by it. The attempt to treat paralysis agitans in a similar manner seemed a logical step. As there was no way of knowing beforehand which pathways should be cut, it was deided to use the technically safer procedure of incising the anterior group alone first.

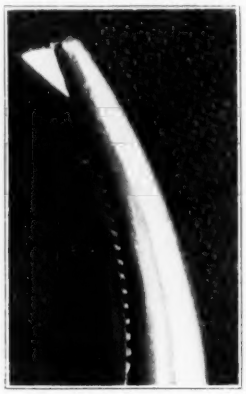

Fig. 5.—Fragment of razor blade, grasped in curved forceps, to gage depth of incision in the cord.

Case 3.—Mary B., aged 18, who was admitted on Nov. 9, 1931, was one of the last of twenty children, of whom nine were dead of unknown causes. She was always mentally and physically backward. In 1929, she had had double vision (without fever), followed in a few months by rigidity and tremor of the right extremities, a masklike face, monotonous voice and incontinence of urine. The condition was evidently one of encephalitic parkinsonism. She was somewhat improved by stramonium in very large doses. She and her parents were pleased with the prospects of an operation.

Examination.—On admission to the hospital, she was greatly retarded mentally. She could not talk intelligibly. The right arm and leg showed "lead-pipe" rigidity and slight tremor. The reflexes were somewhat increased; a Babinski sign was questionable.

Operation.—On November 20, the laminae of the second and third cervical vertebrae were removed, and an incision, about 2 mm. deep, was made across the right anterior quadrant of the cord. This was done by means of a small piece of safety razor blade grasped in the tip of a pair of curved forceps (fig. 5).

Course.—The patient made a good operative recovery, but not the slightest change could be detected in rigidity, tremor, strength, reflexes or sensation.

Second Operation.—As the outlook was miserable, it seemed worth while to cut the right lateral group of extrapyramidal fibers also. This was performed at the same level without incident on November 27, in a manner precisely similar to that described in the two preceding cases.

Again, absolutely no result, either favorable or unfavorable, was observed, and the patient was discharged on December 11, unrelieved.

Comment.—This experiment, apparently a crucial one, was a complete failure, but at least the patient was no worse for her experience. In the next case, the decision was easy.

Fig. 6 (case 4).—Patient before operation.

Case 4.—Beverly H., aged 10, who was admitted on Nov. 10, 1931, is the sister of Harriet (case 1) and came in at her own request to have the same operation done. The patient's birth was normal, and she walked at 13 months. Nothing unusual was noticed until four years before admission, when it was observed that the right arm hung loosely at the side, but was stiff when an attempt was made to manipulate it. Eating, writing, etc., grew difficult. Muscle training and massage were tried without benefit. A year later, the legs became stiff and crossed in walking. Involuntary movements began one year before admission, and increased rapidly until she became unable to stand, sit, eat or write. The family has always considered the child bright. She was in the fifth grade of school.

Physical Examination.—This gave negative results as did the routine laboratory tests.

Neurologic Examination.—The abnormal movements were of two types; a slow wormlike movement, accompanied by great rigidity, especially of the right arm,

and intermittent jerks of wider latitude. It was difficult to make out any periodicity in the movements, as had been observed in the case of Harriet. The condition appeared somewhat more like that of Tommy W. (case 2). There was a tendency for the arms to be held in flexion with the fists clenched. Sometimes the right arm was the seat of rhythmic tremor. Voluntary movements could sometimes be performed, but were usually quickly stopped by spasm. The patient was much better when quiet and relaxed, but even then was almost helpless. She had no pain. Speech was difficult, though never as bad as Harriet's.

Operation.—As the first patient had shown some signs of disturbance of the pyramidal tract, it was thought wiser to cut only the anterior columns. At operation, on November 13, the special knife blade in a clamp was inserted anterior to the cord on the right at the second cervical segment, and was carried across the

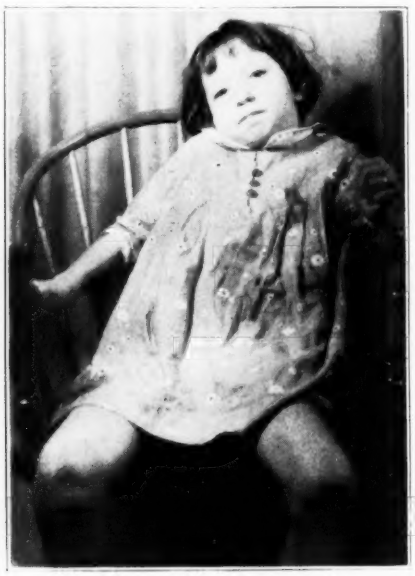

Fig. 7 (case 4).—Patient six months after operation.

anterior surface at a depth of 2 mm. This maneuver was repeated on the left at the third segment.

Course.—The patient made an excellent recovery and was not incontinent. As soon as she came out of the anesthetic she could use both hands and feet. However, a rhythmic movement of the right shoulder persisted, which was extremely annoying.

The patient was discharged on December 4. The movements in the face, neck and right shoulder persisted, but there were none elsewhere. The hands were still clenched, but less rigidly, and the patient could open them. The deep reflexes were within normal limits, and the Babinski sign was absent.

She continued to improve at home for two months, and was able to stand and walk a few steps with assistance, but not to use her hands. She then began to have increasing spasms in the neck and upper extremities, and the legs became weaker and more difficult to control.

When seen on May 2, 1932, she was distinctly euphoric and slightly deteriorated. Speech was worse. She was able to sit up in a chair, which had been impossible before the operation, and could stand with assistance, but walking was impossible. All the extremities were weaker, but they were the seat of only very mild contractions. Coordinated movements were fairly well performed. The deep reflexes were lively but weak. A few jerks of clonus could be obtained on the right, but there was no Babinski sign.

According to a report from the family physician, Dr. Rudd, on July 27, her condition is growing rapidly worse.

Comment.—The question arises whether the lateral set of tracts should also have been sectioned at the operation. This would have endangered the pyramidal tracts and might have added to the weakness. On the other hand, the patient did not experience as much benefit as did her sister. There were no ill results from performing a bilateral section at the level of the second and third segments.

In the last case in this series, a somewhat different problem presented itself. The patient, unlike the previous ones, was in good condition and could care for himself, although he could not work. The possibility of depriving him of the use of his right leg had to be weighed against the possibility of relief from the disabling athetosis. Accordingly, a conservative operation was performed at first—perhaps too conservative, as it had to be repeated.

CASE 5.—Fred B., aged 29, was admitted on Feb. 20, 1932, having been referred by Dr. Nathan Garrick and Dr. Charles Sziklas. The family history was not remarkable. The patient had been well until March, 1923, when he had an acute febrile disease which was diagnosed as pneumonia. On the tenth day he was delirious, and became paralyzed and numb on the right side. The delirium lasted for three weeks. At the end of this time the patient began to improve and was able to be up and about. Ten days later, he began to have convulsive seizures, beginning on the right side. These continued until 1926, when he began taking phenobarbital.

Involuntary movements of the right toe began shortly after the patient's acute illness in 1923. These were particularly annoying in walking. In 1927, involuntary flexor and grasping movements of the right arm and hand began. These had grown more and more severe until the patient had to hold some object, such as a rolled newspaper, to avoid digging his nails into his palm. They were worse with excitement and prevented him from eating, writing with that hand or shaving.

Examination.—The patient was a strong, healthy, well developed man of mediocre intelligence. Speech was rather explosive. There were a complete right homonymous hemianopia, incomplete hemiparesis and slight ataxia of the right leg. The spasms were as already described. They were not painful, but were extremely incapacitating, annoying and embarrassing. Examination of the spinal fluid, including Wassermann and Kahn tests, gave negative results.

An encephalogram showed a dilatation of the left temporal and occipital horns and an extensive area of cortical atrophy in the left parieto-occipital region.

The situation was explained to the patient, and he willingly accepted the risks which operation offered.

Operation.—On March 17, the second to fourth laminae were removed, and part of the arch of the atlas. The incision was made as close to the atlas as possible, about 2 mm. deep, across the anterior surface of the cord, by means of a piece of razor blade in a curved clamp.

Course.—The patient had a rather stormy convalescence, owing chiefly to an intercurrent tonsillitis. Full strength was preserved from the time of operation in both arm and leg. The abnormal movements were entirely relieved for two weeks following the operation. They then began again, but much more mildly than before, so that the patient did not have to hold his right hand with his left to avoid striking himself and objects about him with it. He became able to extend and abduct the arm, but was not able to hold the hand open (fig. 8). Sensation was unimpaired.

The patient's tonsils were removed on April 18 on account of acute tonsillitis. He went home to convalesce and entered the hospital again on May 24, 1932, requesting further relief.

Fig. 8 (case 5).—Patient able to hold affected arm extended and stationary, one month after the first operation.

Second Operation.—On May 28, the old incision was reopened and carried up to the foramen magnum. An incision was made in the right anterior column, about 4 mm. deep, from near the midline to the exit of the lower first cervical anterior root. Smart bleeding ensued, which was controlled by placement of muscle.

Course.—The patient experienced still further relief, though not complete, and was discharged on June 15. He had a hemianalgesia of the left side up to the neck but no loss of ordinary sensation. This condition was unchanged when he reported a month later. The right arm was quiet, except at times of excitement, when it would tremble somewhat. He could use it to dress himself but not to eat with. He was able to write with that hand for the first time in six years.

Comment.—In this case, there is some evidence as to the nature and location of the lesion—probably an encephalitic softening in the parieto-occipital region of the left cerebral hemisphere, extending down to the external geniculate body. This was also the most striking instance of persistence of strength in the affected limbs and of ability to walk.

COMMENT

The surgical results speak for themselves. None of the patients has been made economically self-supporting, but none has been worse for the operation and four of five have been improved. The extent of the improvement is difficult to gage objectively, but it is perhaps significant that three of the patients have of their own accord requested a further, more radical operation, and a fourth has requested operation after seeing its effect on her sister. It is difficult to say whether the effect of the operation will increase or decrease in time. The progressive nature of the disease makes cases 1 and 4 indecisive. In case 2, the improvement appears to have been maintained for a year at least.

The present series is too small to allow more than general conclusions in regard to operative indications and technic. Operation should perhaps be considered in any case in which abnormal movements are persistent and disabling. Few patients are likely to submit to operation if they obtain substantial relief from muscle training, but it is probable that reeducation would be greatly facilitated by an operative diminution of abnormal impulses. Section of the anterior group of tracts is apparently innocuous. How deep the incision should be made anteriorly, and whether the prepyramidal group of fibers should also be severed must be determined by further experience. For the present, a shallow anterior incision, to be made deeper at a second stage if symptoms persist, appears to be the conservative course. Perhaps section of the lateral rubrospinal group may be reserved for a third stage under certain conditions.

From the physiologic point of view it seems justified to conclude that (at least in cases of hyperkinesia of the type here reported) the abnormal impulses do not travel over the pyramidal pathways, and that in man standing and walking are possible in spite of almost complete destruction of the main extrapyramidal pathways. Nor does spasticity appear to be increased by such a procedure. The mechanism of the tremor and rigidity in paralysis agitans remains as mysterious as ever.

SUMMARY AND CONCLUSIONS

1. In two cases of familial dystonia musculorum, one of bilateral choreo-athetosis following an acute infectious disease in infancy and one of unilateral athetosis following an acute infection in adult life, a decrease in the abnormal movements has been brought about by operative section of the prepyramidal and anterior quadrant marginal fibers, or the latter alone, in the cervical cord.

2. The operation was followed by mild signs of pyramidal tract defect in one case and hemianalgesia in another. There were no permanent ill effects from the operation and (except in one case) no sensory loss.

3. In a case of juvenile paralysis agitans following encephalitis, the symptoms were neither relieved nor aggravated by the operation.

Subsequent Note.—Beverly H. (case 4) returned for reoperation on Oct. 21, 1932, while this paper was in press. She was in poor general physical condition, and suffered from severe, almost continuous torticollis and torsion spasm, involving the extremities to a slight extent. Voluntary movement of the extremities was practically impossible, and the sensorium appeared impaired. Realizing the dangers, I performed a deeper chordotomy at about the second cervical segment, and crushed the first three anterior roots on both sides. The patient went through the operation well, but died the following morning.

A man of 37 with a painful paralysis agitans has also been subjected to a bilateral anterior chordotomy. The tremor was unaffected and he regained no strength, but the rigidity appeared somewhat improved and the pain was relieved.

ABSTRACT OF DISCUSSION

Dr. W. G. Spiller, Philadelphia: Dr. Putnam, I think, is the first to cut the extrapyramidal tracts in a human being. He has presented his subject fairly and with a sincere desire to ascertain the truth. He acknowledges that different views are held regarding dystonic movements, and that the location of the extrapyramidal tracts in the spinal cord is uncertain. He is guided largely by experimental work on animals, especially on cats. He acknowledges that experimental evidence in regard to cutting extrapyramidal tracts is contradictory.

He describes two general groups of extrapyramidal tracts, and in the first case he made incisions through both the lateral and anterior columns, cutting both sets of extrapyramidal tracts. That patient showed marked involvement of the motor system, and had exaggerated reflexes. The abnormal movements, however, were relieved, but the involvement of the pyramidal tract may possibly have some connection with the cessation of some of these movements. The patient gradually improved, but relapsed, and signs of involvement of the pyramidal tract became more pronounced.

In the second case the incisions were the same as in the first case, in both the lateral and anterior columns. Dr. Putnam in his other cases cut only the anterior column. The third case was one of encephalitic parkinsonism, and was not successful. In case 4 the incision was made in the anterior cord only, and improvement followed in the dystonic movements, but there seems to have been a relapse. In case 5 the incision was made about 2 mm. deep across the anterior surface of the cord, and the abnormal movements became milder. Dr. Putnam's conclusion is that four of his five patients were improved. The extent of the improvement, he said, is difficult to gage. It is a question whether any of this improvement is the result of cutting the fibers of the crossed pyramidal or direct ventrolateral pyramidal tract.

In 1899 I found a bundle of fibers in the ventrolateral cord, which I traced with difficulty by the Marchi method, fearing that I would lose the connection, from the medulla oblongata into the pons, and found that it came from the pyramidal tract in the pons. I reported it in *Brain* (1899, p. 563) and in the *Neurologisches Centralblatt* (1902, no. 12). The lesion was in the internal capsule. Stanley Barnes later described what was doubtless the same tract in the spinal cord. This tract has received recognition from Obersteiner, Ziehen, Dejerine and Winkler. It is in the part of the anterolateral column which would be cut by Dr. Putnam's method, and it is possible that it may have a connection with some of the weakness that occurred in some of his cases.

The cases that Dr. Putnam has shown in moving pictures are of great interest. It is a radical attempt to relieve these dystonic movements, but we must be cautious in our decision until further experience is gained.

Dr. Frazier and I have had two cases in which the dystonic movements were so much more pronounced in the cervical region that root section seemed advisable, but I do not think that he is any more enthusiastic about the results than I am. I do not think that these patients are benefited by root section.

Dr. Putnam states that anterolateral chordotomy for the relief of pain in man is performed in the region of the extrapyramidal tracts. I do not recall ever having seen any impairment of muscle tone following anterolateral chordotomy for the relief of pain.

Dr. E. Spiegel, Philadelphia: Dr. Putnam's work seems to be a remarkable contribution from the point of view of the therapy of extrapyramidal diseases as well as of their pathophysiology. It shows that impulses for involuntary movements are carried to the lower motor neurons by extrapyramidal pathways, and that the severance of such centrifugal pathways is able to suppress these abnormal movements.

A second problem in these extrapyramidal diseases is the hypertonus of skeletal muscles. A severance of the anterolateral surface of the cord interrupts here not only descending extrapyramidal fibers but also ascending proprioceptive systems, which have to do with the maintenance of muscle tonus.

Several years ago I found that section of the posterior column or of the dorsal spinocerebellar tract, or even the combined lesion of these two systems, had only a slight influence on the tonus; on the other side the lesion of the anterolateral surface of the cord lowered the tonus of the hind leg of this side in cats quite distinctly.

This effect seems to be due partly to the injury of descending fibers and partly to the lesion of the ascending branch of brain stem reflexes, particularly of fibers of the ventral spinocerebellar tract, which sends collaterals to the motor cells of the formatio reticularis rhombencephali.

It might be astonishing that the severance of these proprioceptive reflexes is sometimes not very effective as far as the hypertonus is concerned. But one has to bear in mind that even the severance of the posterior roots sometimes does not lower the hypertonus, because secondary changes develop in hypertonic muscles. When such changes are established, one cannot expect the decrease of the proprioceptive reflexes to lower the pathologic condition. To recognize these secondary changes in the muscle the intramuscular injection of procaine hydrochloride might be useful before the operation, as this drug paralyzes the proprioceptive nerves in the muscles, and should lower the tonus in such cases when secondary changes of the muscles are not yet established.

Dr. T. J. Putnam: I am obliged to Dr. Spiller for pointing out the existence of branches of the pyramidal tract in the anterolateral column. I do not think it possible to be sure that this procedure, even anterior section, does not injure the pyramidal tract anatomically to some extent. From the physiologic point of view, however, pyramidal function was well preserved after the operation in the more successful cases. The last patient, for example, had a firm voluntary grip, and the third patient had excellent movement of the legs, so that I find it hard to believe that it is necessary to sacrifice much of the pyramidal tract, at least in giving the patients as much relief as these have had.

I am greatly obliged to Dr. Spiegel for the suggestion of previous intramuscular injection of procaine hydrochloride. His experimental work has given me a great deal of comfort and support in the beginning of this work, as have also the experimental researches of Dr. Papez and Dr. Ranson which I gratefully acknowledge.

MÉNIÈRE'S DISEASE

DIAGNOSIS AND TREATMENT

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During the past two years we have divided the eighth cranial nerve in eleven patients for the relief of Ménière's disease. This paper is based on the study of ten of these patients, and includes observations on the diagnosis and operative procedure as well as on the results of the treatment.

Ballance [1] proposed division of the eighth cranial nerve in 1894, but the operation was not carried out because the patient's attacks disappeared while he was under observation. In 1908, both Frazier [2] and Ballance sectioned the nerve intracranially. Frazier's patient had vertigo, and was benefited but not entirely relieved by the operation. The patient operated on by Ballance in 1908 for painful tinnitus had previously been operated on for removal of the semicircular canals with relief of the nausea. The tinnitus disappeared four months after section of the acoustic nerve. The patient had a stormy postoperative course. Frazier,[3] in 1905, credited Krause with having divided the eighth nerve for relief of persistent tinnitus, but we have been unable to find an account of his operation in the literature. Doubtless, the operation had been done by others, for Fraser [4] stated, in 1925, that because of the high mortality following section of the eighth nerve, the operation had been abandoned. Whatever the reason, the fact remains that Frazier's success with his case in 1908 did not make sufficient impression at the time to bring the operation into more general use by other surgeons. The failure to utilize section of the eighth nerve for relief of Ménière's

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1. Ballance, C. A.: Essays on the Surgery of the Temporal Bone, New York, The Macmillan Company, 1919, vol. 2.

2. Frazier, C. H.: Intracranial Division of the Auditory Nerve for Persistent Aural Vertigo, Surg., Gynec. & Obst. **15**:524 (Nov.) 1912.

3. Frazier, C. H.: New York M. J. **81**:272 (Feb. 11); 280 (Feb. 18) 1905.

4. Fraser, J. S., in Turner: Text Book on Diseases of the Nose, Throat and Ear, New York, William Wood & Company, 1925, p. 369.

disease could hardly have been due to inadequate surgical technic, for the operation was fully described by Frazier, and his technic, except for improved anesthesia, is essentially that in use at the present time. It is more probable that the operation did not become popular because an adequate clinical conception of Ménière's disease was lacking, and because aural vertigo with unilateral acoustic symptoms had not been accurately differentiated from the many other conditions causing vertigo. A clearcut surgical Ménière syndrome was proposed by Dandy [5] in 1928, in a stimulating and valuable paper in which he reviewed the literature of Ménière's disease and emphasized its characteristic features. In this paper he reported nine cases in which he had divided the eighth nerve, with relief in every case. Our results with ten cases of section of the acoustic nerve for the relief of Ménière's syndrome are similar in all important respects to those reported by Dandy in his paper.

As in major trigeminal neuralgia, the patients with Ménière's disease selected for operation should have a syndrome so typical that the diagnosis is never uncertain. This syndrome consists of paroxysms of vertigo with nausea and vomiting, persistent tinnitus in one ear and partial deafness in the ear to which the tinnitus is referred. The tinnitus is generally constant after onset, although it may vary in intensity with exaggeration during the seizures of vertigo, and rarely it may be intermittent. Ballance stated that "vomiting follows in bursts, and tinnitus becomes a howling" during the attacks. The duration of the attacks of vertigo may be momentary, or the attacks may last for several hours. The violence of the vertigo may cause the patient to fall and receive severe injury of the head, as happened to one of the patients in our series. This patient was rendered unconscious by the injury, but there was no disturbance of consciousness in any other patient in the group. Generally, the patient has sufficient time after the onset of vertigo to reach a recumbent position without injury to himself. In some cases, the patient becomes bedridden either from the vertigo or from fear of attacks, and as the disease progresses an unsteadiness with more or less constant dizziness may continue between the attacks, a condition referred to by Oppenheim [6] and others as the *status Ménière*. Disability resulting from Ménière's disease arises principally from the sudden attacks of vertigo and, to a much lesser extent, from the unsteadiness that may persist between the attacks. The patient shows little concern for the unilateral deafness, which is an invariable part of the syndrome. Charcot thought that when the patient becomes entirely deaf in the affected

5. Dandy, W. E.: Ménière's Disease: Its Diagnosis and a Method of Treatment, Arch. Surg. **16**:1127 (June) 1928.

6. Oppenheim, Hermann: Text-Book of Nervous Diseases, translated by Alexander Bruce, Edinburgh, O. Schulze & Co., 1911, vol. 2, p. 1195.

ear the vertigo disappears. From our experience there seems to be some reason to doubt that such is the case.

We believe that certain patients with an undoubted history of Ménière's attacks, who have a chronic dizziness with tinnitus and complete deafness on the affected side, may with propriety be subjected to the operation. Every patient in our series was carefully studied by the otologist before operation, to exclude any local aural condition that might be a cause of vertigo. No treatment previous to section of the nerve has appeared to have the slightest effect in relieving any of the patients in this group. In no case has the operation been done unless the patient had been seriously incapacitated by the disease.

The type of vertigo of Ménière's disease may be similar to that produced by lesions remote from the acoustic nerve or its end-organs, and on the vertigo alone a diagnosis cannot be made. The combination, however, of sudden attacks of vertigo with unilateral tinnitus and progressive deafness in the ear which is the seat of the tinnitus constitutes a surgical syndrome, and relief of the disability may be expected by section of the homolateral eighth nerve. We hesitate to express an opinion as to the pathology of Ménière's disease, but there is good reason to doubt that the lesion is in the semicircular canals. Because of the dizziness, one immediately thinks of the vestibular portion of the nerve as being mainly implicated in the disease process. In view of the fact, however, that eight of our ten patients had normal vestibular responses to the caloric test, it might be inferred that the vestibular nerve is not involved. It is more probable that the nature of the pathologic change is such as to escape detection by the tests of vestibular function now in general use. In one case (case 1) in which the patient had vestibular responses to the caloric test after the operation, owing to incomplete section of the vestibular nerve, the relief of both vertigo and tinnitus was complete. We have not intentionally spared any portion of the nerve at operation, in view of the fact that the pathology of the disease is unknown. Even if the cochlear and vestibular portion of the nerve could be precisely separated, which is practically impossible, we believe that the entire nerve should be divided.

The operation for relief of Ménière's disease presents no great difficulties to those experienced in neurologic surgery. A curved incision is made over the suboccipital region on the affected side, from a point on a level with the tip of the mastoid process and running upward, then inward and downward to the midline (fig. 1). The importance of placing the bony opening laterally as far as possible without entering the mastoid cells is appreciated at once, because the most direct approach to the cerebellopontile angle is along a line parallel to the posterior surface of the pyramid. Both Frazier and Dandy called attention to the importance of releasing the fluid from the basal cisterns so that access

to the nerve may be obtained without forcible retraction of the cerebellum. Every effort should be made to avoid hemorrhage about the nerve. The arachnoid covering should be carefully removed before an effort is made to separate the eighth nerve from the facial nerve. If a hemorrhage about the nerve occurs on division of the eighth nerve, facial paralysis is likely to result. Even the application of a small bit of muscle or wet cotton pledget to control the bleeding is likely, in our opinion, to be followed in a few days by a marked facial weakness, if not actual paralysis on the side of the operation. The exposure of the nerve should be adequate, but forcible retraction, which is entirely

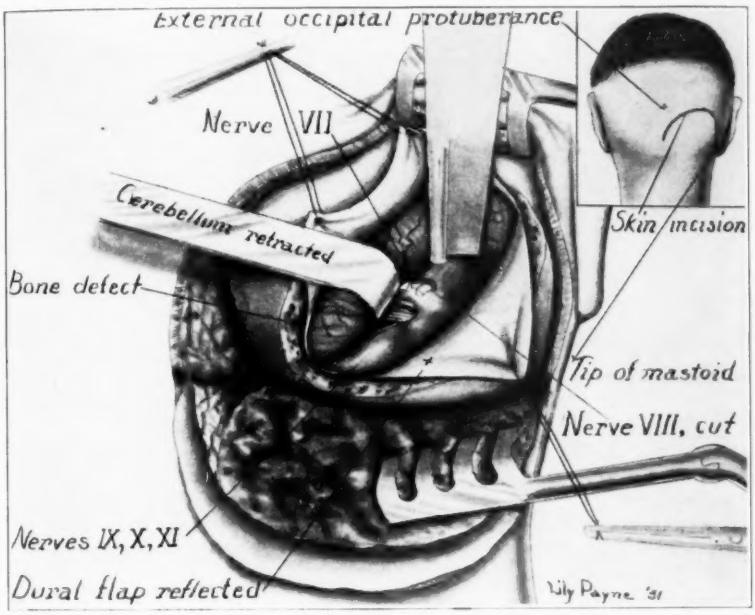

Fig. 1.—Intracranial section of the eighth nerve for Ménière's disease. The facial and intermediate nerves are entirely covered by the eighth nerve, which must be drawn aside so that the facial nerve may be identified.

unnecessary, should be avoided if the facial nerve is to be protected from damage. We have observed some variations in the nerve at operation. In one case there seemed to be a definite division of the nerve into two parts. Such a division of the nerve might be expected as an occasional finding. We have performed the majority of the operations under local anesthesia. The seventh and eighth nerves have been identified entirely by location and appearance. Electrical stimulation for identification of the facial nerve is unnecessary. The auditory nerve is first examined for abnormalities, and is then hooked up and divided with a long, sharp-pointed knife.

In some cases a slight nystagmus may be present for a few days after operation, but we have had no other symptoms referable to injury of the cerebellum or the pons. Some patients complain of numbness above the incision. Perhaps this may be avoided in the future by an incision so planned as not to injure the sensory nerves of the occiput. Unsteadiness may be present also, and tinnitus, while always modified, is not invariably abolished. In no case in this small group of ten patients has there been an attack of vertigo since the operation. Paradoxical as it may seem, most of the patients have stated that hearing was improved by the operation, notwithstanding the sacrifice of the auditory portion of the affected nerve. Improved hearing after the operation is due to the relief or lessening of the disturbing tinnitus.

From our experience with these ten cases, we believe that section of the eighth nerve intracranially for the relief of Ménière's disease gives results which compare favorably with those following the modern operation for relief of major trigeminal neuralgia. The operations have been performed with practically the same technic in all cases. The following brief reports summarize the main features of the cases.

REPORT OF CASES

Case 1.—R. L. J., a man, aged 39, gave a history of the sudden onset of deafness in the left ear one year before coming under our observation; it was followed in three days by an attack of vomiting and dizziness. Ten days later, he began to have ringing in this ear. He had had some dizziness and tinnitus almost constantly, and frequently had sudden attacks during which he was unable to be up. For the past year he had not been able to do any work, having been bedridden most of the time. Nearly every day he had a sensation of hot flushes and tingling passing over the entire left side, lasting about ten minutes. He felt better while lying on the right side; lying on the left side made him more dizzy. Objects seemed to move to the left. Any movement of the head caused dizziness.

The past history was without significance, except for an attack of influenza in 1918.

Examination.—Physical examination gave negative findings, except for signs of chronically infected tonsils. The blood pressure was normal.

Neurologic examination gave negative results, except for deafness in the left ear.

Otologic examination, made by Dr. E. T. Gatewood, showed that the drum and tube of the right ear were normal. The static labyrinth function was normal. Hearing showed a 20 per cent loss (mixed type). The drum and tube of the left ear were normal. The static labyrinth function was normal. Hearing showed a 50 per cent loss.

Operation and Course.—On May 15, 1930, the left eighth cranial nerve was divided under nitrous oxide-ether anesthesia. There were no abnormal findings. The patient had a normal postoperative course and was discharged on May 28. The otologic findings after operation were: The right ear was normal. The static labyrinth function of the left ear was normal. Hearing showed a 100 per cent loss. The patient was last seen on April 30, 1932, when he stated that he had had no attacks of dizziness or vomiting. The ringing in the ear had entirely disappeared,

and he heard more distinctly than he did before the operation because of relief of the tinnitus. He had not lost any time from work since recovery from the operation.

CASE 2.—L. M., a woman, aged 54, for the past thirteen years had suffered with tinnitus in both ears, associated with dizziness, nausea and vomiting. For the past seven years tinnitus had been constant in the right ear. Hearing was impaired on this side. Any sudden movement of the head increased the dizziness. She had noticed some difficulty in walking because of vertigo for the past four months. During the seizures, objects seemed to be moving to the right, and the patient was unable to stand. The symptoms were equally severe with lying on either side. Tinnitus was much more pronounced during these attacks, and was continuous.

The past history was unimportant, except for tonsillitis previous to removal of the tonsils four years before admission.

Examination.—Physical examination gave negative results. The blood pressure was 148 systolic and 82 diastolic.

Neurologic examination gave negative results, except for impaired hearing in the right ear and a slight tendency to fall to the left when walking.

Laboratory tests, including spinal fluid examination and Wassermann reactions, gave normal results.

Otologic examination, made by Dr. T. E. Hughes, showed that the right ear had a 50 per cent loss of hearing; the left ear, a 15 per cent loss. The caloric test showed a normal reaction.

Operation and Course.—On May 19, 1930, under nitrous oxide-ether anesthesia, the right eighth cranial nerve was divided. No abnormal findings were encountered.

The postoperative course was normal except for some dizziness and vomiting during the first few days. The patient remarked as follows: "I feel more calm and easy than I have for twelve years. I feel so different." She was discharged from the hospital on June 12, 1930. This patient was last seen on April 21, 1932, when she stated that she had not had any attacks of dizziness since the operation, but that she had a slight unsteadiness of gait. She still had slight tinnitus in the right ear. Movement of the head did not cause dizziness. She had gained 20 pounds (9 Kg.) since the operation. Otologic examination after the operation showed that the right ear was completely deaf and failed to respond to the caloric test.

CASE 3.—F. L., a man, aged 50, a traveling salesman, gave a history of an attack of dizziness eight months before admission to the hospital. This attack lasted about ten minutes, but was not of sufficient severity to cause him to lose his balance. He had had similar attacks about once a month following the initial attack. Two months before coming under our observation, the patient had a severe attack of dizziness with vomiting, lasting thirty minutes, during which he had to either sit or lie down. He had had several such attacks since. He had been growing deaf in the right ear for nearly a year, with tinnitus on this side for about one month. There were throbbing and pain in the head following the dizziness. During the seizures he felt as though he were turning to the left. The patient was more comfortable when lying on his back; if he lay on the right side, the dizziness was increased. The patient had had pneumonia and an abscess of the lung when 18 years of age. He had had herpes zoster on the chest three years prior to admission.

Examination.—Physical examination gave negative results. The blood pressure was 142 systolic and 78 diastolic.

Neurologic examination gave negative results, except for impaired hearing on the right.

Laboratory tests, including a spinal fluid examination, gave normal results.

Otologic examination, made by Dr. E. T. Gatewood, showed that the right ear drum was normal. The tube was normal. The mastoid was normal. There was a normally functioning static labyrinth. The cochlea showed 36 per cent loss of hearing (mixed). The left ear was normal.

Operation and Course.—On June 2, 1930, section of the right eighth cranial nerve was done under nitrous oxide-ether anesthesia. There were no abnormal findings.

After the operation the patient had nausea and vomiting for about five days. On the day of operation, and following it, right facial weakness of the peripheral type was noticed. This gradually became almost complete. The patient was entirely relieved of tinnitus and dizziness, and was discharged on June 19. He accepted the temporary facial paralysis without complaint in view of the prompt relief of vertigo and tinnitus afforded by the operation.

The postoperative otologic findings were: There were a nonfunctioning static labyrinth and complete deafness in the right ear. The left ear was normal.

The facial paralysis cleared up two months after the operation. The patient was last heard from on April 19, 1932, when he stated that since the operation there had been no dizziness and the ringing in the right ear was completely relieved. He said: "I feel that the operation was a complete success."

Case 4.—J. S., a man, aged 42, gave a history of exposure to a cold wind, five months before admission to the hospital, which was followed by earache on the right side. This passed off in a few minutes, but later on the same day there developed a ringing in both ears. During that day the ringing ceased in the left ear, but continued in the right ear. On the following morning he tried to get up, but became dizzy, with increasing ringing in the right ear followed by nausea and vomiting. He was confined to bed for nine days. After that he was able to be up, but was not able to work. Any sudden movement of the head increased the ringing in the affected ear and caused dizziness which was sometimes associated with nausea. The patient stated that during the attacks he seemed to be turning around, but was unable to say in which direction. He was more comfortable when lying on the right side. Lying on the left side increased the dizziness.

The past history was without significance, except for some rheumatism in past years.

Examination.—Physical examination showed nothing abnormal except a slightly enlarged heart and signs of aortic stenosis. There was no history of decompensation. The blood pressure was 110 systolic and 80 diastolic.

Neurologic examination gave normal results, except for a slightly larger right pupil.

Laboratory examinations gave normal results.

Otologic examination, made by Dr. E. T. Gatewood, showed that the right ear drum was normal; the tube was open. The mastoid was normal; the static labyrinth showed definite nystagmus and subnormal vertigo after three minutes of caloric stimulation. Hearing showed a 53 per cent loss (mixed type). All the findings in the left ear were normal except for 18 per cent loss of hearing.

Operation and Course.—On Feb. 5, 1931, section of the right eighth cranial nerve was done, with no unusual findings.

The patient made a good postoperative recovery, with relief from the dizziness and tinnitus. He was discharged on February 24.

Postoperative otologic examination revealed: No nystagmus or vertigo was induced in the right ear; hearing was present for loud tones. The left ear was unchanged.

On April 19, 1932, the patient wrote that he had been entirely relieved of dizziness and that most of the ringing in the ear had disappeared.

CASE 5.—J. W., a man, aged 50, a farmer, two years before coming under our observation, while plowing suddenly became dizzy and had to sit down. The attack lasted about five minutes. Later during the same year he had several similar attacks. He did not know whether or not he had tinnitus at the time of these attacks. Six months later, while walking about the yard, he suddenly became dizzy and had to be helped to the house and put to bed. He vomited, and every time he moved his head he became dizzy. He felt as though he were going round and round. Surrounding objects seemed to be turning upward and then to the left. He felt better while lying on his back, although dizziness was not increased by lying on either side. Ten months before admission to the hospital, he suddenly fell to the ground from dizziness and had to be carried home. At this time he had tinnitus in the left ear, accompanied by nausea and vomiting. Two months later, while at a hotel in this city, he suddenly became dizzy and fell to the floor, receiving an injury of the head with unconsciousness for fifteen minutes. He was carried to Memorial Hospital, where a spinal puncture showed a bloody fluid. When he fell he struck his forehead. Two months after that attack he again fell because of sudden dizziness, and this time he fell backward. The patient had several more such attacks and was greatly disabled. There was constant tinnitus in the left ear.

He had had typhoid fever at 18 and rheumatism at 26 years of age. He had one child who was epileptic and eight normal children.

Examination.—Physical examination gave negative results. The blood pressure was 140 systolic and 90 diastolic.

Neurologic examination showed that the right pupil was slightly larger than the left, but both reacted normally. There was weakness of the left internal rectus muscle, which had existed throughout the patient's life. Hearing was impaired in the left ear.

Laboratory examinations gave normal results.

Otologic examination, made by Dr. E. T. Gatewood, showed a loss of hearing of 17 per cent in the right ear, and a loss of hearing of 22 per cent in the left ear. The vestibular responses were normal on both sides.

Operation and Course.—On June 6, 1931, under local anesthesia, section was made of the left eighth cranial nerve. A small vessel was encountered running along the nerve, but this gave no trouble. When the eighth nerve was handled, the patient complained of much dizziness and noise in the left ear.

Postoperative recovery was satisfactory, with relief of all symptoms except slight tinnitus in the left ear. The patient was discharged on June 28.

Postoperative otologic examination revealed: The findings in the right ear were unchanged. The static labyrinth of the left ear showed partial function (subnormal nystagmus). The cochlea showed a complete loss of hearing.

The patient was last heard from on April 19, 1932, when he said that he had not had any dizziness since the operation, but still had some tinnitus.

CASE 6.—L. M., a woman, aged 59, had always been weak and nervous. One year before coming under our observation, she began to have ringing and impairment of hearing in the right ear, associated with attacks of dizziness. The attacks were sudden in onset; during them she had to be supported or to lie down. They were accompanied by nausea and vomiting and lasted for from five minutes to an hour. The last attack began five weeks before admission to the hospital, and was just beginning to wear off when she was admitted. Hearing in the right ear had become progressively impaired. During the seizures, surrounding objects appeared to be moving from the right to the left, and when the attacks became more severe

objects seemed to move backward and forward. The patient was more comfortable when lying on the right side, as dizziness was increased by lying on the left side.

She had had infantile paralysis at 5 years of age, which was followed by weakness of the right leg.

Examination.—Physical examination showed that the patient was frail and had arteriosclerosis and palpitation of the heart. The blood pressure was 138 systolic and 78 diastolic.

Neurologic examination gave negative results, except for impaired hearing in the right ear.

Laboratory examinations gave normal results.

Otologic examination, made by Dr. E. T. Gatewood, showed that the eustachian tubes were patent. The hearing in the right ear was reduced to 50 per cent; that in the left ear was reduced to 14 per cent (mixed type). Caloric stimulation showed normal reactions in both ears.

Operation and Course.—On June 22, 1931, under local anesthesia, the right eighth cranial nerve was divided. The seventh and intermedius nerves were easily seen and preserved. There were numerous vessels about the nerve, a condition that was somewhat unusual. The patient complained of extreme dizziness when the nerve was manipulated.

The postoperative course was normal. Taste was normal on both sides of the tongue at the time of the patient's discharge from the hospital, on July 20, 1931.

Postoperative otologic examination revealed: The static labyrinth of the right ear gave no response; the cochlea showed complete deafness; the condition of the left ear was unchanged.

The patient was examined on March 7, 1932, when she stated that she had had no attacks of vertigo, but that slight ringing in the right ear had persisted. She had had an attack of influenza six weeks previous to this examination, and since then had had some pain in the back of the head and an area of numbness on the right side. She felt that she had been greatly benefited by the operation, although she was somewhat unsteady in walking.

Case 7.—I. L., a man, aged 42, gave a history of having suffered for six months with sudden attacks of dizziness, nausea and vomiting. During the attacks he was unable to stand. He suffered with shortness of breath, but was never unconscious. He had tinnitus in the right ear, and had been deaf in this ear for a long while. The attacks of dizziness lasted for one or two minutes. Any movement of the head or stooping over might bring on an attack. Surrounding objects appeared to tilt over half way to the right and then return to the former position. The patient felt better when lying on the right side. His past history was without significance.

Examination.—Physical examination gave normal results except for some weakness of the internal rectus muscle, which had been of long duration. There was questionable lateral nystagmus to the left.

Laboratory tests gave normal results.

Otologic examination, made by Dr. E. T. Gatewood, showed that there was an impaction of wax in the canal of the right ear; the drum was normal; the tube was restricted; the static labyrinth function was normal. The left ear drum was normal; the tube was restricted; the static labyrinth was normal; the cochlea showed a 20 per cent loss of hearing (mixed).

Operation and Course.—On June 23, 1931, section of the right eighth cranial nerve was made under local anesthesia. The seventh and intermedius nerves were easily identified and preserved.

The postoperative course was normal. The patient's sense of taste was normal on discharge from the hospital on July 8, 1931.

Otologic examination showed that the static labyrinth was nonfunctioning; there was complete deafness. The condition of the left ear was unchanged.

The patient was seen on April 21, 1932, when he stated that he had not had a return of the attacks of dizziness. He still had slight dizziness when stooping over or turning quickly, however. There had been no ringing in the ear since the operation. He thought that his hearing was as acute as before the operation; he had lost no time from work.

CASE 8.—C. McW., a man, aged 58, had worked as a boiler-maker until eight years prior to coming under our observation, when he had to give up work because of roaring in the right ear. The roaring persisted, and three years later he suddenly became dizzy, fell backward to the floor and had nausea and vomiting. There was no loss of consciousness. At that time he was also growing deaf in the right ear. He had no other attacks for three years, but continued to have noise in the right ear. The second attack was similar to the first, and he had two or three attacks in one week. One month before admission to the hospital, he had another series of attacks of vertigo. He has gradually become deaf in the right ear, and frequently had headache in the occipital region. During the attacks of dizziness the patient did not feel that he was turning or spinning, but that he was moving forward in one direction. This was especially noticed on movement of the head or on looking up. On looking down he had a feeling of the floor moving upward toward him. He was more comfortable when lying on the right side, as dizziness was increased by lying on the left side. Because of dizziness he was unable to work. His past history was without significance.

Examination.—Physical examination gave negative results. The blood pressure was 127 systolic and 68 diastolic.

Neurologic examination revealed a slight nystagmus to the right.

Laboratory examinations gave normal results.

Otologic examination, made by Dr. T. E. Hughes, showed that with the right ear, a watch could be heard on contact; with the left ear, a watch could be heard at 2 inches (5 cm.). The reactions of vestibular function were normal to the caloric test on both sides.

Operation and Course.—On Jan. 28, 1932, section was made of the right eighth cranial nerve under local anesthesia. There were no abnormal findings.

The patient made a good recovery and was discharged from the hospital on February 27, much improved. Twenty-five days after the operation, tests showed no response from the right labyrinth and the right ear was entirely deaf.

The patient was heard from on April 29, when he wrote: "I still have some dizziness, but it is not so severe. The ringing has stopped. I have not had the 'falling out' spells since the operation."

CASE 9.—D. B., a man, aged 43, a machinist, five years prior to coming under our observation was taken with a sudden attack of dizziness and roaring in the right ear, associated with nausea and vomiting. The attack lasted for an hour, and he was confined to bed. Following this attack he noticed a gradually increasing deafness in the right ear, and he had constant roaring in this ear. One year later, he had a second attack which was similar to the first in severity and duration. After this, he had an attack every six months for two or three years. Recently, he had had them more frequently—on an average of about once a week. The patient had become disabled for his occupation. The noise in the right ear he described as being like the ringing of metal, and this sound was intensified during the

attacks. He felt as though he were swaying from side to side, but he could not tell whether he or surrounding objects appeared to be turning. He was more comfortable when lying on the right side. His past history was without significance; there was no history of disease of the middle ear.

Examination.—Physical examination gave negative results. The blood pressure was 125 systolic and 75 diastolic.

Neurologic examination gave negative results, except for absence of abdominal reflexes and deafness in the right ear.

Laboratory examinations gave normal results.

Otologic examination, made by Dr. E. C. Bryce, showed that there was about 66 per cent loss of hearing in the right ear. The left ear was normal. Vestibular function was normal in both ears.

Operation and Course.—On March 25, 1932, under local anesthesia, section was made of the right eighth cranial nerve. Nothing abnormal was found at the operation.

Course.—For a few days after the operation the patient had some nausea, vomiting and slight tinnitus. These symptoms gradually cleared up. Ten days after the operation, he said that he still had some noise in the right ear, but not nearly so loud as before. The tinnitus was intermittent, while it had been continuous before the operation. The patient said that he heard as well as before the operation, although he did not hear with the right ear. There was no dizziness at this time. There was preservation of the sense of taste, but some impairment on the anterior half of the tongue. The patient was discharged on April 10. One month after the operation, otologic tests showed complete deafness and no vestibular response to caloric stimulation on the right side. On April 30, the patient stated that he had had no sudden attacks of vertigo or vomiting, but that he had had some unsteadiness of station and slight tinnitus.

Case 10.—L. W., a woman, aged 49, complained of dizziness and roaring in the right ear for five years prior to coming under our observation. Dizziness was more or less constant, but was not present during the attacks at first. Three years later, she was operated on for acute mastoiditis on the right side. During the following week she had a severe attack of vertigo, which was intensified by a change in posture and was accompanied by nausea. The noise in this ear was more annoying if she lay on the left side, and she was more comfortable when lying either on the right side or on the back. She had some pain in the right side of the head during the attacks, and there was occasional vomiting. The patient described the noise in the right ear as resembling the hissing of steam escaping, but said that during the attacks it was more like the ringing of bells. She had been growing deaf for five years, and had been totally deaf in the right ear since the operation on the mastoid two years previously. The patient stated that she experienced considerable dizziness when turning from one side to the other while in a recumbent position and in walking, but was unable to tell whether or not the objects about her seemed to move. There was no spinning sensation, but perhaps a feeling of swaying.

The past history revealed nothing of importance except the right mastoidectomy. The patient's son was killed in an airplane accident, which caused her much grief.

Examination.—Physical examination gave negative results. The blood pressure was 120 systolic and 72 diastolic.

Neurologic examination gave negative results, except for complete nerve deafness in the right ear.

Otologic examination, made by Dr. John Dunn, showed that there was a complete loss of hearing and vestibular function in the right ear. The left ear was normal.

Laboratory examinations gave normal results, including a negative Wassermann reaction.

Operation and Course.—On April 7, 1932, under local anesthesia, section was made of the right eighth cranial nerve. Nothing unusual was found except a good sized vessel lying on the nerve. This vessel was pushed aside and not severed.

The patient made a good postoperative recovery. She compalined of some noise in the head immediately after the operation, but did not have dizziness and headache as before. She was seen on discharge from the hospital on April 22, about two weeks after the operation. At that time she was walking about, but complained of some unsteadiness. She had had attacks of vertigo since the operation. The tinnitus in the right ear had not entirely disappeared at the time of discharge. This patient's general morale and health had been greatly impaired by

Fig. 2 (case 10).—Incision thirteen days after operation.

an invalidism of five years' duration. She had not recovered sufficiently from the operation on discharge from the hospital to determine the permanent results of section of the nerve.

COMMENT

The ages of these ten patients varied from 39 to 59 years. There were three women and seven men. The longest duration of the attacks of vertigo was thirteen years; the shortest was six months. The tinnitus and deafness were in the left ear in two cases and in the right in eight. The degree of deafness varies from 22 to 100 per cent in the affected ear. In no case was there absence of impairment of hearing as stated by the patient, or on examination by the otologist. There was diminished hearing in the opposite ear in seven cases, but this was not great and was not recognized by the patient. Nearly all of the patients stated that they heard more distinctly after the operation than before, due most

likely to the removal or modification of the disturbing tinnitus in the affected ear. The tinnitus was described as being continuous in all but two cases, and these two patients stated that the ringing was noticed only during the attacks of vertigo. Six patients stated that they were more comfortable when lying on the same side as the deaf ear. One said that there seemed to be less disturbance when he lay on the opposite side, and three, while they lay on the back. Some stated that lying on the affected ear seemed to shut out the noise. During the seizures of vertigo, the patients described the sensation of objects moving toward the affected ear in four cases, and to the opposite in one case. One patient said that he felt that he was moving in the opposite direction from the affected ear, and one that he seemed to be moving straight forward, and on looking down the ground appeared to move upward to meet him. Two others stated that there was a sensation of general swaying. It would appear from these observations that there is no constant relation between the ear involved and the direction of the apparent movement of the patient and the surrounding objects. Half of the patients had the sensation of objects moving toward the side of the affected ear.

The caloric test was used in all cases for examination of the vestibular function. It was described as normal in the affected ear in all except two; in one of these the reaction was subnormal and in the other showed no response.

In all of the cases there were nausea and vomiting associated with dizziness. The constant findings in all cases were vertigo, nausea, vomiting, unilateral deafness and tinnitus. The other findings were all inconstant, such as the sensation of objects (or the patient himself) turning, the direction of their movement, the character of the tinnitus, as to whether continuous or intermittent, pains about the occiput, the position of the patient during the attack and the vestibular function as shown by the caloric tests.

The patients' hearing and vestibular function were tested at some time during the first month after operation. The patient in case 10 as yet has not had this examination made. Hers was the most recent case, and she was operated on about a month ago. The preoperative findings in this case showed complete loss of cochlear and vestibular function on the affected side. It may be assumed that the postoperative findings will be the same. It may be said that, since the eighth nerve showed no function to the ordinary tests in this case, there could be no indication for dividing it. We thought over this case carefully before operation, taking into consideration the total disability of the patient, her insistence on the operation and the probability of some slight nerve function being present which escaped detection on examination. Since the operation, this patient has not had any of the attacks of vertigo, nausea and vomiting, but still has some slight tinnitus and some

unsteadiness of station and gait. In a letter from the patient's husband, a physician, on May 30, 1932, he stated that the operation has done her much good, and that "she has some dizziness but not nearly so much as she had before the operation, and not nearly so much tinnitus. I believe she is going to fully recover."

In case 1, the otologic findings showed that the vestibular function was normal, with complete deafness on the affected side after the operation. This was unexpected, and the only conclusion drawn from it is that the vestibular portion of the nerve was not divided completely. In this particular case, the patient has been entirely relieved of dizziness and tinnitus for more than a year. There has been no suggestion of attacks of vertigo since the operation, although he was practically bedridden for a year before. Should the attacks of vertigo return and future tests show preservation of vestibular function, it might be advisable to operate again and divide the remaining portion of the nerve. The results in this case are perfectly satisfactory to the patient.

Case 5 showed slight vestibular function with complete deafness on examination after operation. In this case, the patient was completely relieved of the dizziness, but slight tinnitus persisted. In the two cases which showed some preservation of vestibular function on the affected side after operation, there was complete relief of vertigo. The patients did not complain of any unsteadiness of station or gait, especially on stooping over or turning quickly, as in several postoperative cases in which the test showed complete loss of vestibular function.

In case 4, after the operation there seemed to be some hearing for loud tones in the affected ear. The slight tinnitus after operation in this case is not evidence of incomplete section of the nerve, as there were five other cases in which tinnitus persisted to some extent after operation with the test showing complete loss of hearing. There were four cases of complete relief from the tinnitus, while the remaining patients stated that it was not as disturbing as before. In no case since the operation has there been a recurrence of the sudden attacks of vertigo which characterized the Ménière syndrome. In six cases there was slight unsteadiness of station and gait, especially on change of posture, since the operation, while in four, none of these symptoms were found. Three patients complaining of unsteadiness on sudden changes of position, or on walking, were operated on less than six months ago, and it is likely that this unsteadiness will improve or disappear altogether. The first seven patients were operated on over a year ago; three of them complain of unsteadiness and four do not.

Case 3 was the only one in which facial paralysis developed following the operation. This cleared up completely in two months.

SUMMARY

1. A report is made of ten cases of intracranial section of the eighth nerve for the relief of Ménière's disease. The operation may be done with a negligible risk. Recovery from operation was prompt in every case.

2. The diagnosis is based on a history of attacks of violent vertigo accompanied by nausea and vomiting, tinnitus in one ear and partial deafness in the same ear.

3. No attack of vertigo has followed the operation in any case, although some of the patients have had a slight unsteadiness, particularly on sudden change of position or quick movements. This unsteadiness tends to improve with time, and is not disabling. Tinnitus, when not entirely abolished by the operation, has been changed, and improved in every case. Our experience with this group of ten patients leads to the conclusion that intracranial section of the eighth nerve is highly successful in relieving the disability of Ménière's disease.

ABSTRACT OF DISCUSSION

Dr. W. E. Dandy, Baltimore: There is little to be added to Dr. Coleman's paper, except for me to say that I am in entire accord.

I have now operated on thirty patients with Ménière's disease without any mortality, and in not a single case has there been an attack subsequent to the operation.

There is doubtless a close analogy between the trigeminal neuralgia and Ménière's disease. It seems probable that both are due to an anatomic change in the sensory roots. It is, of course, most important to make an accurate diagnosis of Ménière's disease. The diagnosis is established by the subtotal deafness and the tinnitus in the same ear. There are attacks of pseudo-Ménière's disease exactly like those of Ménière's disease, but there are not the associated subtotal deafness and the tinnitus.

Section of the eighth nerve causes no loss of function except the remaining hearing, which is of no practical use. In about half of the cases there is postoperative dizziness for varying periods of time, a dizziness entirely different from that of Ménière's disease. It is prompted by turning the head and lasts for only a few moments. It may continue for from a few days to a few months. In half the cases it is entirely absent. Why the difference, I do not know.

Dr. Israel Strauss, New York: We neurologists know how terribly patients with this syndrome suffer, and this operation, offering such a hope of relief, is a valuable contribution. However, I am struck with the figures that Dr. Coleman showed in this respect: Seven patients had tinnitus after operation.

Why should tinnitus remain if the nerve is completely resected? If in such cases there was not a complete resection of the nerve, I should think that that procedure would be indicated.

Dr. Wilder Penfield, Montreal, Canada: How frequently has there been subsequent evidence of advanced involvement of Ménière's process in the opposite ear?

My understanding of the condition is that it is eventually a bilateral process, and that the deafness and the tinnitus, which affect one ear, may be expected to advance later into the other ear.

It seems to me that the eventual evaluation of this treatment must depend on how rapidly and how frequently the process may advance into the opposite side.

DR. C. C. COLEMAN, Richmond, Va.: I did not emphasize the fact that destruction of the hearing in the affected ear was never complained of by the patients. In fact, the hearing of the ear with tinnitus is of no practical value, and, paradoxical as it may seem, most patients have stated that they have heard more distinctly after the operation than they did before, owing to the removal of the interfering tinnitus.

The tinnitus, as Dr. Strauss stated, is not always relieved, but it has been invariably modified and improved. One would expect tinnitus to be entirely removed by the operation, but the tinnitus may be caused by lesions that are not located in the auditory nerve or its end-organs. Its persistence after operation does not necessarily mean that the cochlear portion of the nerve has not been divided. The disability of Ménière's disease seems to consist chiefly in paroxysmal attacks of vertigo, and secondarily in tinnitus and loss of hearing, which is rarely complained of by the patient.

In reply to Dr. Penfield, we have not observed these cases long enough to know whether the disease will become bilateral. We have operated on no patient with Ménière's disease who had bilateral tinnitus. Observation over a long period of time may confirm his suspicion that the disease will develop in the opposite side, as occasionally is true in trigeminal neuralgia. Our first patient was operated on two years ago.

In no patient has there been an attack of vertigo since the operation, so we think that from experience with these cases the operation compares favorably in its results with that of the modern operation for major trigeminal neuralgia.

STENOSIS OF THE AQUEDUCT OF SYLVIUS

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In 1760, Morgagni published some rather pertinent views on the subject of hydrocephalus. Among his many speculations appears one that is singularly appropriate:[1]

> Indeed the greatest part of observers do not allow the disorder to be a hydrocephalus when the head is not enlarged. Yet there is not the least doubt, but that when a large quantity of water is by degrees collected in the cranium, a tumor of the head must infallibly arise therefrom, if it were possible for the bones to yield to the extension, as they do in young creatures: nor can it be doubted, but some of the causes, which give rise to the congestion of water in the heads of tender infants, are the same that give rise to the congestion in adults. . . . Suppose, for instance, either such a structure or constitution of the pineal gland, that it can transmit no water.

This eighteenth century pathologist, although he had but feeble glimmerings as to the modern conception of circulation of cerebrospinal fluid, at least was right in his hypothesis that hydrocephalus may afflict older patients, and, moreover, without the grotesque and hideous enlargement of the head usually associated with the disease in infants.

There are already abundant and excellent treatises on the subject of hydrocephalus in infancy and early childhood, and physicians have sufficient familiarity with cases of children who before or shortly after birth present progressive enlargement of the cranium and general enfeeblement and die early. It might be of more interest, therefore, to study a small group of somewhat older patients suffering from chronic internal hydrocephalus from various causes, but all having the one common feature of narrowing of the aqueduct of Sylvius as the main anatomic reason for the damming up of cerebrospinal fluid. Since they are older, and therefore are at a stage in life when the cranium is inextensible, the patients in this group, with one exception, lack the characteristic enlargement of the head that is so conspicuous a feature in younger patients. The condition was chronic in all cases, and in many

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From the Section on Neurology and the Section on Pathologic Anatomy, the Mayo Clinic.

Read at the Fifty-Eighth Annual Meeting of the American Neurological Association, Atlantic City, N. J., June 7, 1932.

1. Morgagni, J. B.: The Seats and Causes of Diseases Investigated by Anatomy, London, A. Millar and T. Cadell, 1769, vol. 1, p. 246.

even a hint as to the origin of the progressive stasis of the circulation of the cerebrospinal fluid was lacking. In none was there any indication of abnormal birth or development or any history of a previous inflammatory process.

Inflammatory processes involving the ependyma and subependymal tissues in a chronic manner are as yet little known or understood. Unfortunately they are not too rare to constitute a clinical diagnostic problem.

REPORT OF CASES

CASE 1.—A woman, aged 23, came to the Mayo Clinic on Dec. 20, 1922, complaining of blindness of the right eye and failing vision in the left eye. Four years before, she had noticed some disturbance in vision in the right eye, and this had progressed. About the same time, menstrual periods, which previously had been regular, occurred only at intervals of two or three months, and the flow was scant. A year later she had a severe left supra-orbital headache in attacks lasting for a few hours. Eighteen months before she came to the clinic, vision of the right eye had failed so that she was able only to distinguish light. A year before she came to the clinic, vision of the left eye began to fail, and became progressively worse. She had gained 20 pounds (9 Kg.) in weight.

The patient weighed about 140 pounds (63.5 Kg.), which was overweight for her. The blood pressure in millimeters of mercury was 108 systolic and 68 diastolic. A roentgenogram of the skull gave evidence of enlargement of the sella turcica, with thinning of the posterior clinoid processes. The Wassermann test of the blood was negative. On examination, vision in the right eye was absent; in the left eye it was 4/60. There was edema of from 1 to 2 diopters in the right eye, with marked pallor of the disk, and papilledema of the left eye of from 1 to 2 diopters, with a pale disk. The ophthalmologic picture was essentially that of secondary optic atrophy. There were no neurologic data of importance. A diagnosis of unlocalized tumor of the brain was made.

A ventriculogram was made on Dec. 27, 1922. There were markedly increased intracranial pressure and marked dilatation of both lateral and third ventricles. Neither the aqueduct nor the fourth ventricle could be visualized. The diagnosis by ventriculogram was obstruction of the aqueduct of Sylvius. The patient apparently recovered from the immediate effects of ventriculography but died suddenly six days later.

At necropsy, the organs of the thorax and abdomen appeared normal. On removal of the brain, no cerebrospinal fluid was found in the subarachnoid spaces, and the convolutions were flattened. There were erosion and destruction of the posterior clinoid processes, and the floor of the third ventricle bulged markedly. There was no exudate over any part of the brain, and the arachnoid was not opaque or thickened in any place. When the brain was opened, marked internal hydrocephalus of the lateral and third ventricles was found; the fourth ventricle was normal in size. Granular ependymitis was present on the walls of all the ventricles. The aqueduct of Sylvius was narrow, but complete obstruction could not be demonstrated anatomically. Microscopic study of the meninges and cortex of the brain revealed no abnormality or sign of inflammation. In sections through the walls of the ventricles were seen collections of lymphocytes around all the blood vessels in the subependymal glial zone. These collections of lymphocytes were present only about vessels near the ependymal surfaces, and not about vessels deeper in the tissue of the brain. Similar perivascular collections of lymphocytes

were present in the vessels in the subependymal glia, around the walls of the aqueduct of Sylvius (fig. 1). In addition to the lymphocytes in the perivascular spaces, there was marked proliferation of the subependymal glia, which had proliferated irregularly and had given the walls the appearance of so-called granular ependymitis. In the areas between the granules there was similar glial proliferation, but this was less marked than at the granules. The tops of the granules were usually devoid of ependymal cells, whereas in the hollows the ependymal cells were normal. Frequently, at the bases of the granules, ependymal cells were embedded in the glial tissue. There was no sign anywhere in the brain of acute or subacute inflammation; the signs of inflammation were entirely chronic, associated with proliferation of the subependymal glia. There were no signs of proliferation of the perivascular connective tissue.

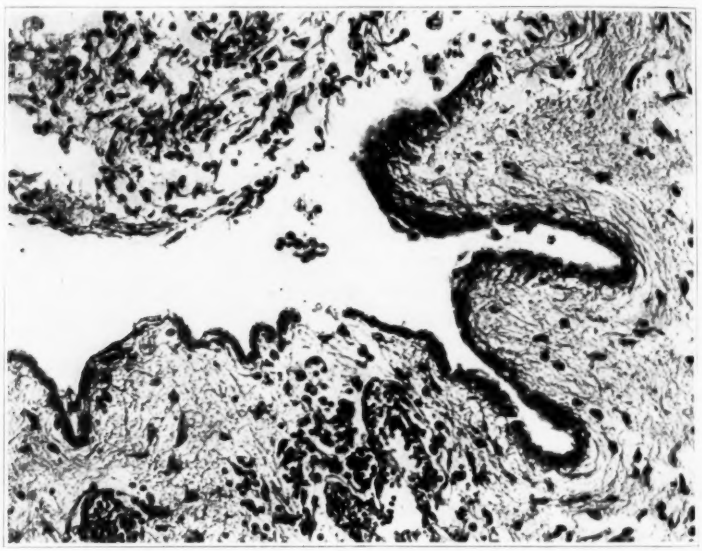

Fig. 1.—Lymphocytes in the perivascular space of the subependymal glial zone. Also note proliferation of the subependymal glia, giving the ependymal surface the appearance of so-called granular ependymitis. Hematoxylin and eosin; × 165.

Comment.—From the clinical standpoint, there were no indications of the actual cause of the internal hydrocephalus as demonstrated by ventriculographic study. All that could be said was that the patient had increased intracranial pressure and internal hydrocephalus due to obstruction somewhere between the oral end of the aqueduct of Sylvius and the foramina of Magendie and of Luschka in the roof of the fourth ventricle. Had the patient lived, it would have been necessary to exclude tumor by cerebellar exploration and by examination of the cavity of the fourth ventricle. Encephalographic investigation would have been contraindicated because of the risk of cerebellomedullary herniation through the foramen magnum.

The pathologic changes represent a chronic inflammatory process in the ependyma, more particularly in the tissues underlying the ependymal layer. The proliferative changes in this subependymal glia were marked, and had resulted in narrowing of the aqueduct. Even in more acute cases of ependymitis, some proliferative changes are always present in the underlying glia, but necessarily the more chronic the process the more marked is this glial hyperplasia, and in time it may come to dominate the histologic appearance of the region of the aqueduct, and nearly all evidence of previous inflammation may be lacking. Further, there is a slow gradation from more acute cases to those of extreme chronicity, and one stage merges imperceptibly into the other.

In Orton's [2] case of occlusion of the aqueduct from chronic ependymitis signs of inflammation were scant, and yet there was marked overgrowth of subependymal glia. Case 6 reported by us in a previous contribution [3] was somewhat similar in that there was diffuse proliferation of the subependymal tissues, forming innumerable small granules. In that case also the aqueduct was occluded by glial proliferation. All outline of the canal was lost, and its lumen was filled with hyperplastic glial tissue. The more acute phase of ependymitis is illustrated in a case described by Globus and Strauss.[4] In some portions of ependyma the process was acute and purulent; in others, however, a chronic granular state could be seen. The ependyma lining the aqueduct was entirely disorganized and was replaced by a wide zone of homogenized necrotic tissue, giving the impression of a hyalinized band entirely separated from the underlying subependymal glia. This layer was in the form of a wide zone of gliosis, and farther orally the ependyma and some of the glia underneath had separated from the walls of the third ventricle, forming a pseudocystic mass obstructing the oral end of the aqueduct. Case 5 reported by us in a previous article [3] was also somewhat more acute in its manifestations. In that case, the ependymal lining of the lateral and third ventricles was converted into a thick gelatinous layer, composed mainly of a mass of chronic inflammatory cells. The aqueduct was blocked by a cellular exudate.

The puzzling feature of the cases just described was the utter lack of any manifest cause. In none was there any history of a preceding inflammatory toxic or infectious episode, and, generally speaking, the actual cause of these chronic and subacute cases of ependymitis is somewhat of a mystery. As usual, syphilis has been suggested as a cause, and possibly was present in the next case to be described (case 2).

2. Orton, S. T.: Clinical and Pathological Study of Two Cases of Obstruction of the Aqueduct of Sylvius, Bull. Neurol. Inst., New York, **1**:72 (Jan.) 1931.

3. Shelden, W. D.; Parker, H. L., and Kernohan, J. W.: Occlusion of the Aqueduct of Sylvius, Arch. Neurol. & Psychiat. **23**:1183 (June) 1930.

4. Globus, J. H., and Strauss, Israel: Subacute Diffuse Ependymitis, Arch. Neurol. & Psychiat. **19**:623 (April) 1928.

However, absence of tangible evidence of syphilis is more the rule than the exception in the condition under consideration. Chronic granular ependymitis, it is true, is a frequent concomitant of dementia paralytica, but it is seen also in a variety of other diseases. Thurwachter,[5] among others, mentioned multiple sclerosis, tuberous sclerosis and even senile dementia. In the more chronic forms, in cases in which active inflammatory changes are absent, chronic granular ependymitis has been considered, particularly by Margulis,[6] to be a sclerotic rather than an inflammatory process, and five different phases of ependymitis have been described by Merle.[7] It is probable that these conceptions depended largely on the actual stage the ependymitis had reached when the patient died, as well as on its relative virulence. In case 2, in which the clinical course was more rapid than that in case 1, the pathologic changes were of somewhat greater chronicity. The ependymal surfaces were unchanged, but the same subependymal proliferation and infiltration of round cells in the perivascular spaces were present to a less degree.

Case 2.—A man, aged 35, came to the Mayo Clinic on Aug. 24, 1931, because of headaches. Fifteen months before he had noticed sudden, severe pain in the temporal and occipital regions when straightening up from a stooping position. These pains became gradually more frequent, and finally occurred in crises of severe pain which wakened him from sleep. Sitting up in bed produced some relief. For the twelve months before we saw him he had also had constant, dull, bitemporal headache on turning his head; sudden straining at stool or coughing would also initiate a paroxysm of excruciating, knifelike pain. Six months before, he had become unusually drowsy and sleepy, and his memory as well as his mental concentration had failed. Four months before, slight unsteadiness in walking appeared, with bilateral diminution of hearing. All symptoms had become progressively worse during the two weeks prior to his visit. He said that he had not had syphilis but that he had had gonorrhea at the age of 18.

The patient was well developed and well nourished; he weighed 182 pounds (82.6 Kg.) and had a slightly unsteady gait. There was papilledema of the optic disks of from 1 to 2 diopters. Roentgenograms of the skull gave evidence of marked destruction of the sella turcica and of the posterior clinoid processes. There was slight rigidity of the muscles of the neck as well as tenderness to percussion over both the temporal and occipital regions of the skull. Hearing was only slightly reduced, and altogether the neurologic findings were not marked. The Kahn and Kline flocculation tests of the blood for syphilis were positive; unfortunately, confirmation of these tests was not obtained by the use of the Kolmer modification of the Wassermann test. This test also was negative with the spinal fluid; the Nonne test was negative; the total protein in each cubic centimeter of fluid was 20 mg., and only one lymphocyte was found in each cubic millimeter. The pressure of the spinal fluid was 320 mm. of water.

5. Thurwachter, Ludwig, quoted by Globus and Strauss.[4]

6. Margulis, M. S.: Pathologische Anatomie und Pathogenese der Ependymitis granularis, Arch. f. Psychiat. **52**:780 (Oct.) 1913.

7. Merle, Pierre: Étude sur les épendymites cérébrales, Thèse, Paris, 1910, no. 305.

Clinically, the condition was regarded as possibly a tumor of the fourth ventricle, because of the sudden crises of pain, the rigidity of the neck, the occasional crises of hiccup and the transient ataxia. Syphilis was also considered as a possible cause of the symptoms, but the completely normal spinal fluid disarmed suspicion, and, even if the existence of syphilis were admitted, the presence of a coexisting tumor had necessarily to be excluded. Further information was sought by ventriculography on Aug. 29, 1931, and satisfactory plates were obtained (fig. 2). Both lateral and third ventricles were seen to be enormously distended, but the fourth ventricle could not be visualized. Of still greater significance was prolongation of the outline of the third ventricle into the oral third of the aqueduct as a funnel-shaped projection ending abruptly (fig. 2). This was interpreted as indicating an obstruction of the aqueduct at the juncture of its middle and oral thirds. There was naturally some doubt as to the nature of the obstruction. Again,

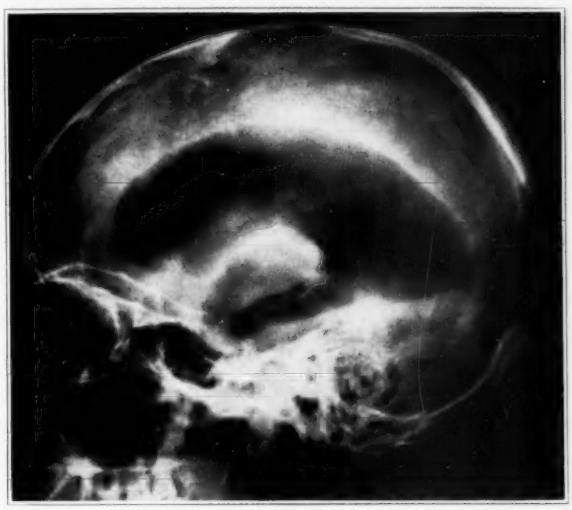

Fig. 2.—Ventriculogram in case 2. The arrow points to funnel-shaped dilatation of the anterior third of the aqueduct of Sylvius. The remaining portion of the aqueduct and the fourth ventricle cannot be visualized.

a tumor filling the fourth ventricle and projecting into the aqueduct could not be excluded from the possibilities of diagnosis.

Cerebellar exploration and decompression were performed on Sept. 1, 1931. No tumor was found, even though the vermis cerebelli was split and the whole of the fourth ventricle was exposed. The fourth ventricle was not enlarged, and incomplete obstruction of the aqueduct of Sylvius was demonstrated at operation. The surgical diagnosis was ependymitis of the aqueduct of Sylvius. Following operation, the patient failed steadily, his blood pressure increased, his pulse and respirations were irregular, and finally hyperthermia appeared. He died on September 5.

Necropsy was limited to that which could be performed through the cerebellar decompression wound; thus, the brain was removed in pieces. This prohibited careful examination of the aqueduct of Sylvius. There was, however, well marked internal hydrocephalus involving the lateral and third ventricles, but none of the

fourth ventricle. The convolutions were flattened, and the arachnoid was definitely thickened and opaque, especially around the base and in the interpeduncular fossa. The ependyma of the third ventricle and the aqueduct of Sylvius had a gelatinous appearance, but the site of the occlusion of the aqueduct could not be demonstrated, for it had been torn during removal. Microscopic examination gave evidence of chronic arachnoiditis around the base, with increase in connective tissue, and many lymphocytes were included in the connective tissue, but especially around blood vessels. Most of the connective tissue was of the adult type, but there were also many fibroblasts. No polymorphonuclear leukocytes were present. Sections of the floor of the third ventricle and sections taken through the walls of the aqueduct of Sylvius gave evidence of marked proliferation of the subependymal glia, and occasional groups of ependymal cells were separated from the surface ependyma and were lying in the subependymal glial tissue. The

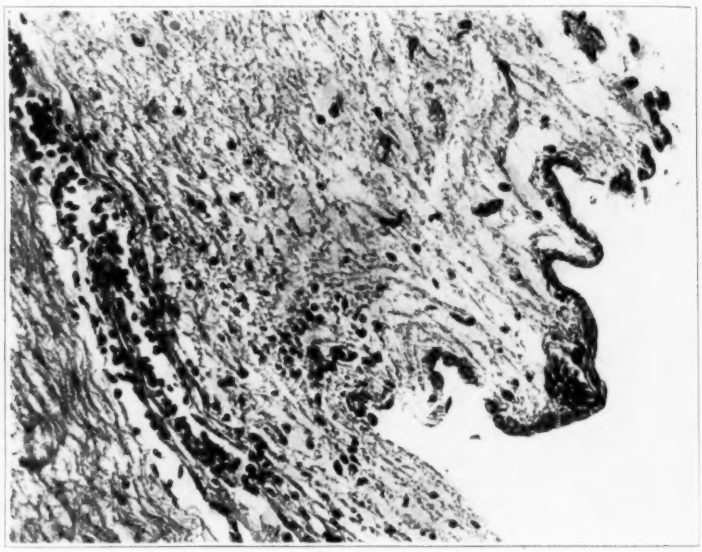

Fig. 3.—A collection of lymphocytes in the perivascular space of the subependymal glia. Plasma cells were also present. Hematoxylin and eosin; × 225.

ependymal cells seemed to be normal, and there was no actual proliferation of these cells. Around every blood vessel in the subependymal glial zone there were many lymphocytes and plasma cells (fig. 3), but no polymorphonuclear leukocytes or other evidences of acute inflammation. Sections from the walls of other portions of the ventricular system gave evidence of milder proliferation of the subependymal glia, and there were some lymphocytes in the perivascular spaces of the subependymal blood vessels. The diagnosis based on necropsy observations was chronic leptomeningitis of the base, and chronic ependymitis, with stricture of the aqueduct of Sylvius, all presumably of syphilitic origin.

Comment.—That this last case was chronic was obvious when microscopic examination of the tissues was made, and the pathologic changes were essentially those of subependymal proliferation; occasional vessels were surrounded by lymphocytes. The ependymal layer was relatively

intact, and the granulations that were so conspicuous in the first case recorded were absent. Nevertheless, the aqueduct had become narrowed, and clinical symptoms inevitably followed. Syphilis was assumed to be the cause; although admittedly this presumption cannot be proved beyond doubt, when all the facts of the case, clinical and pathologic, are considered, its existence cannot be denied. The clinical course was shorter than that in the first case, but this would, of course, depend on the rapidity with which the aqueduct became occluded, which in turn would depend on some uncertain factors.

As for examples of a further degree of chronicity, cases have been reported wherein all signs of frank inflammation were absent. There was no perivascular inflammation, but merely diffuse proliferation of the subependymal glia, most marked in the walls of the third and fourth ventricles, and in the periaqueductal tissue. As before, the aqueduct became narrowed, and internal hydrocephalus was thus produced. The origin and nature of this phenomenon of hyperplasia have been considerably debated, as will be developed later. The cases already described, however, give some assistance in interpretation and represent steps in an increasing scale of chronicity.

CASE 3.—A boy, aged 6, was brought to the Mayo Clinic on March 4, 1931, because of progressive enlargement of the head. Birth and development in infancy had been normal, but when he was 2 months of age the mother had noticed that his head was unusually large, and as measured by the family physician it was found to be 48 cm. in circumference. In spite of repeated tapping of the ventricle, the head continued to enlarge, and the mother had to change the size of the child's hats more frequently than is normal. Nevertheless, his first teeth erupted at 7 months; he walked at 12 months, and commenced to talk at 20 months. Thereafter, he developed mentally and physically at about the same rate as other children of his age. A month previous to examination he complained of headache, and he had become less ambitious and less active.

Mentally the child was normal; he was well developed and well nourished, and weighed 46 pounds. The circumference of his head was 61.5 cm. He was not confined to bed and complained of no particular discomfort. On ophthalmologic examination, pale, full disks were found, with some exaggeration of the scleral rings, but vision seemed normal. The Wassermann test of the blood was negative, and roentgenologic studies of the skull disclosed that it was enlarged and the sutures were separated. The outline was that of a hydrocephalic skull. Neurologic examination disclosed nothing unusual; the child was somewhat fidgety.

On March 10, 1931, a ventricular puncture was made with the patient under general anesthesia, and indigo carmine was injected. The dye did not appear in the fluid obtained by cisternal puncture. Accordingly, obstruction either of the aqueduct of Sylvius or of the fourth ventricle was assumed to be present. On the following day, also with the patient under general anesthesia, bilateral cerebellar exploration was performed, with cerebellar decompression and removal of the arch of the atlas and of the posterior part of the foramen magnum. After the tapping of the posterior horn of the lateral ventricle, the dura was opened and the cerebellum and fourth ventricle were inspected. Nothing unusual was found, except that dye could not be seen coming through the aqueduct of Sylvius. After an opening

was made in the region of the aqueduct, blue cerebrospinal fluid gushed forth. The operation was then concluded, and the wound was closed in the usual manner. During the four or five hours following, the patient rallied from the effects of the operation, moved all his limbs and spoke in a normal fashion. Later, the temperature rapidly rose to 106 F. and the pulse rate correspondingly increased. The boy died suddenly ten hours after the operation.

The brain was removed through the wound made for cerebellar decompression. The cerebellum, medulla oblongata and fourth ventricle were found to be normal; there was no opacity or thickening of the arachnoid, and arachnoid adhesions were not present in the posterior fossa. When the cerebral hemispheres were removed they collapsed, owing to marked internal hydrocephalus of the lateral and third ventricles. The massa intermedia was threadlike, and the septum pellucidum had been stretched and perforated. There was no sign of acute or chronic inflammation

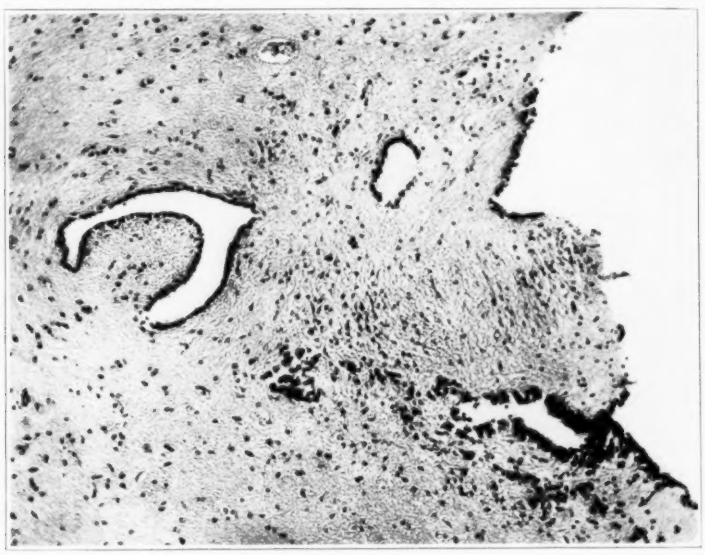

Fig. 4.—Marked proliferation of the subependymal glia which has projected upward and encroached on the lumen of the aqueduct of Sylvius, leading to its narrowing. Islands and tubules of ependymal cells have been isolated by this process. Hematoxylin and eosin; × 95.

in the ventricular system or in the meninges. Cross-sections through the midbrain revealed that the aqueduct of Sylvius was extremely narrow, and in places identification was impossible. Microscopic examination of the brain disclosed the entire absence of any chronic inflammatory reaction, and there was no thickening of the meninges. Sections through the midbrain showed that the aqueduct of Sylvius was made up of numerous small canals lined with ependyma; one of these was larger than the others. There was definite proliferation of the subependymal glia which had projected into the lumen of the aqueduct and spread laterally, cutting off small masses and tubules of ependymal cells from the main canal, which was extremely narrow and only potentially patent (fig. 4). The subependymal tissue was made up entirely of glia cells and fibrils, and no connective tissue was present, as demonstrated by the Mallory phosphotungstic acid-hematoxylin stain. There

was no evidence of inflammation in this glial reaction or around the blood vessels. Sections through the walls of the lateral third and fourth ventricles disclosed similar, but much less marked, proliferation of the subependymal glia, with isolation of small masses and tubules of ependymal cells, a condition that was present in the aqueduct of Sylvius.

The rate of progress of the cranial enlargement in this case was somewhat slower than in the average case of hydrocephalus in childhood, and apart from this deformity the mental and physical progress was interfered with little. At the most, however, the child would scarcely have survived the first decade of life. From the pathologic standpoint the essential feature was proliferation of the subependymal glia in the walls of the third and fourth ventricles and around the aqueduct. There were no signs of an active inflammatory process; perivascular round cell infiltration was absent, and the ependymal layer was everywhere intact.

Comment.—As might be understood, subependymal proliferation probably causes no symptoms when it occurs in the large ventricular spaces, but the narrow aqueduct of Sylvius tolerates this change poorly, and its lumen necessarily becomes encroached on. The essential cause of the subependymal gliosis has been much discussed. So far, two main causes have been postulated; namely, involutional or developmental hyperplasia of the subependymal glia, analogous to that occurring around the central canal of the cord, and proliferative changes in the glia secondary to some previous inflammatory process that has passed, leaving a scar compressing the aqueduct.

As far as the first possibility is concerned, Kernohan [8] has observed that the lumen of the spinal canal, in a large majority of cases, becomes obliterated between the ninth and seventeenth years of life through a process of subependymal overgrowth. Spiller [9] examined thirty-eight specimens taken at random from the midbrain, and found that there was marked variation in the size and shape of the aqueduct and in the density of the subependymal glia, suggesting potentialities of overgrowth. Spiller [10] also first drew attention to the fact that the aqueduct of Sylvius is a homolog of the spinal central canal, and that the aqueduct may undergo, by developmental error, closure similar to that of the central canal at about the same time in life. Spiller's [10] patient was a youth, aged 19, who had suffered from headaches nearly all his life; this symptom suggests that the aqueduct was congenitally narrowed. Six months before death, however, symptoms of internal hydrocephalus developed, and at necropsy a very small aqueduct was found, surrounded

8. Kernohan, J. W.: Cortical Anomalies, Ventricular Heterotopias and Occlusion of the Aqueduct of Sylvius, Arch. Neurol. & Psychiat. **23**:460 (March) 1930.

9. Spiller, W. G.: Syringoencephalia (Syringoencephalomyelia). The Function of the Pyramidal Tract, J. Nerv. & Ment. Dis. **44**:395 (Nov.) 1916.

10. Spiller, W. G.: Two Cases of Partial Internal Hydrocephalus from Closure of the Interventricular Passages, Am. J. M. Sc. **124**:44 (July) 1902.

by dense, proliferated neuroglia. The ependymal lining was relatively intact, and numerous tubules and nests of ependymal cells surrounded the narrowed canal.

Dijkstra's [11] patient was a woman, aged 27, who had had repeated attacks of unconsciousness of short duration for fourteen months before death. As in Spiller's case, signs of internal hydrocephalus had appeared, and similar changes were found around the aqueduct, of which the lining was also intact. Dijkstra specifically mentioned that there were no signs of previous or past inflammation. Orton observed the case of a hydrocephalic imbecile, who survived until the age of 46. The aqueduct was entirely obliterated at about its middle portion by a dense, firm, neuroglial partition crossing it at right angles to its long axis. Serial sections disclosed a few small tubules, establishing communication between the third and fourth ventricles. There was no evidence of active inflammation. Two cases were recorded by us [3] in a previous contribution. These concerned a boy aged 14 and a girl aged 11 years, and the pathologic characteristics of the periaqueductal gliosis were in the main similar to those described by others whose reports have been mentioned in this paragraph.

Among the opponents of the hypothesis that developmental error is the cause of the condition under consideration has been Dandy.[12] He has assumed the intervention of some toxic, inflammatory or traumatic process occurring before or after birth. This is supposed to injure the ependymal lining of the aqueduct and to bring about secondary glial overgrowth to repair the insult; this, in turn, forms a scar contracting and stenosing the aqueduct. He has argued that in a case sufficiently chronic all signs of the previous toxic inflammatory or traumatic process may have disappeared, leaving a scar without trace of the processes causing it. According to this, occlusion of the canal may be postponed until months or years have elapsed after the original noxious process has ceased to act. Dandy further has argued that the fact that the aqueduct is occluded only in part of its length is ground for the belief that there is an inflammatory origin of the structure. Schlapp and Gere [13] were of a similar opinion; in their eight cases of hydrocephalus due to occlusion of the aqueduct, four were due to a periaqueductal gliosis. In two of these cases, active inflammatory processes could still be seen. Including not only the cases reported in the present contribu-

11. Dijkstra, O. H.: Hydrocephalus from Stenosis and Obstruction of the Aqueduct of Sylvius, Nederl. tijdschr. v. geneesk. **74**:5685 (Nov. 22) 1930.

12. Dandy, W. E.: The Diagnosis and Treatment of Hydrocephalus Resulting from Strictures of the Aqueduct of Sylvius, Surg., Gynec. & Obst. **31**:340 (Oct.) 1920. Dandy, W. E., and Blackfan, K. D.: Internal Hydrocephalus, Am. J. Dis. Child. **14**:424 (Dec.) 1917.

13. Schlapp, M. G., and Gere, Belden: Occlusion of the Aqueduct of Sylvius in Relation to Internal Hydrocephalus, Am. J. Dis. Child. **13**:461 (June) 1917.

tion, but many others reported in the literature, an imperceptible gradation of chronicity can be traced, from cases manifestly and obviously inflammatory in origin to the more simple cases of subependymal gliosis which no longer retain any vestige of the original inflammatory processes that brought them into being. In connection with these cases in which the original process has disappeared, Margulis tried to argue an analogy with syringomyelia, and although he postulated a fundamental developmental error and a potentiality to neuroglial overgrowth, he was forced to assume that there was some toxic, traumatic or inflammatory process which started the process into activity. In the final analysis, it is probable that the majority of cases of subependymal proliferation, with occlusion of the aqueduct of Sylvius, have an inflammatory or toxic basis, and that a few, in which the hyperplastic changes are confined to the region surrounding the aqueduct, owe their origin to a developmental error analogous to the changes normally occurring around the central canal of the spinal cord. In an individual case it may be impossible to distinguish the two, and, as Orton stated, no hard and fast line can be drawn between them.

So far, occlusion or stenosis of the aqueduct has been attributed either to cellular exudates or to overgrowth of the surrounding glia; it appears, however, that at necropsy an aqueduct may be found that is extremely small, or that is deformed by duplication or bridging, and that no other tissue changes may be present. The subependymal glia may be normal, and evidence of previous inflammation or injury may be lacking, even after most careful microscopic examination of the tissues. This narrowed channel of cerebrospinal fluid apparently may be competent, and therefore hydrocephalus may not be present. The condition may be found purely accidentally, at necropsy of a patient who has died from some other disease than internal hydrocephalus. Oppenheim [14] described such a state as being present in a case in which death occurred from myasthenia gravis. The aqueduct was narrow and bridged by a band of glial tissue. On the other hand, at some time in life, the canal may cease to function and internal hydrocephalus may appear, with the usual concomitant symptoms. Spiller and Allen [15] reported the case of a woman who had reached the age of 62. Although some evidence of previous enlargement of the skull had existed since early in life, and although she was reputed to have been weak and sickly as a child, she had, nevertheless, led an active life. There was no actual paralysis beyond a certain lameness in gait. She was subject to epilepsy, but was

14. Oppenheim, Hermann: Text-Book of Nervous Diseases, London, T. N. Foulis, 1911, vol. 2, p. 1035.

15. Spiller, W. G., and Allen, A. R.: Internal Hydrocephalus with Report of Two Cases, One Resulting from Occlusion of the Aqueduct of Sylvius, J. A. M. A. 48:1225 (April 13) 1907.

fairly well developed. The patient whose case Dijkstra reported was a boy, aged 16, who died eight days following the onset of symptoms of increased intracranial pressure. Apparently he had been completely normal hitherto. In both instances, necropsy disclosed simple narrowing of the aqueduct, without any evidence of inflammation or of proliferation of the periaqueductal tissues. The first patient in de Lange's [16] series had a similar abnormality, but did not survive after two years and ten months, and was obviously hydrocephalic from birth. It is reasonable to assume, in all such cases, the occurrence of developmental error producing too narrow an aqueduct. During the process of normal fetal development, the canal is at first relatively large, but later becomes narrow, and this process may go too far. Further, reference might again be made to Spiller's work, showing the marked variation in the size, shape and arrangement of the normal aqueduct. Symptoms may never appear, since the canal may remain competent; on the other hand, some intermittent injury or disease may upset the balance, leading to increased intracranial pressure and death.

In case 4, the patient, who was a victim of epilepsy, died suddenly and mysteriously, and at necropsy a small aqueduct was found, without internal hydrocephalus, a purely accidental observation.

Case 4.—A girl, aged 11, was brought to the Mayo Clinic on Sept. 18, 1929, because of convulsive seizures. Her birth and early development had been normal, and she started to attend school at the usual age. At the age of 3 years she had her first convulsion, and thereafter convulsions had continued to occur at the rate of about fifteen a year. They were general, and were preceded by an aura, consisting of a peculiar sensation in the epigastrium. Attacks occurred both at night and in the daytime.

The patient was undernourished, weighing 62.5 pounds (28.3 Kg.); yet there were no obvious signs of physical or mental impairment. Ophthalmologic examination gave negative results; the Wassermann and Pirquet tests were negative. Roentgenologic studies of the thorax revealed no evidence of disease; those of the skull showed the shadows of a normal sella turcica, but digitation in the bone indicated previous increased intracranial pressure.

A diagnosis of grand mal was made, and the child was given a ketogenic diet. She had been on the dietary regimen for ten days, and had had one major attack. On the evening of Oct. 2, 1931, when feeling perfectly well, she prepared for bed. Suddenly she had the usual premonitory sensation of a convulsion, flung herself on the bed, had a severe convulsion, and died.

At necropsy, a normal amount of cerebrospinal fluid was found in the subarachnoid space, and there was no evidence of increased intracranial pressure. There was slight opacity or thickening of the arachnoid around the base, but no evidence of any acute or subacute inflammation. The brain was cut by coronal section; there was no internal hydrocephalus, and no tumor or hemorrhage was present. There was no evidence of any acute inflammatory process, although there

16. de Lange, Cornelia: Klinische und pathologisch-anatomische Mitteilungen über Hydrocephalus chronicus congenitus und acquisitus, Ztschr. f. d. ges. Neurol. u. Psychiat. **120**:433, 1929.

was slight injection of the floor of the third ventricle, especially at its posterior end, and the anterior ostium of the aqueduct of Sylvius was patent. Microscopic study of the various parts of the brain gave negative results, except that it disclosed chronic arachnoiditis around the base, with slight perivascular infiltration, and the ependyma of the floor of the third ventricle was the site of proliferative changes, but of no other signs of inflammation. Cross-sections through the midbrain disclosed that the aqueduct of Sylvius was very narrow. It seemed to be narrowed laterally, and at the middle of this narrow channel there was a broad band of glial tissue separating the aqueduct into two portions (fig. 5). There was slight proliferation of the subependymal glia, but it was negligible.

Next to inflammatory and hyperplastic processes, a sufficient number of cases have been reported of tuberculous tumor invading the midbrain,

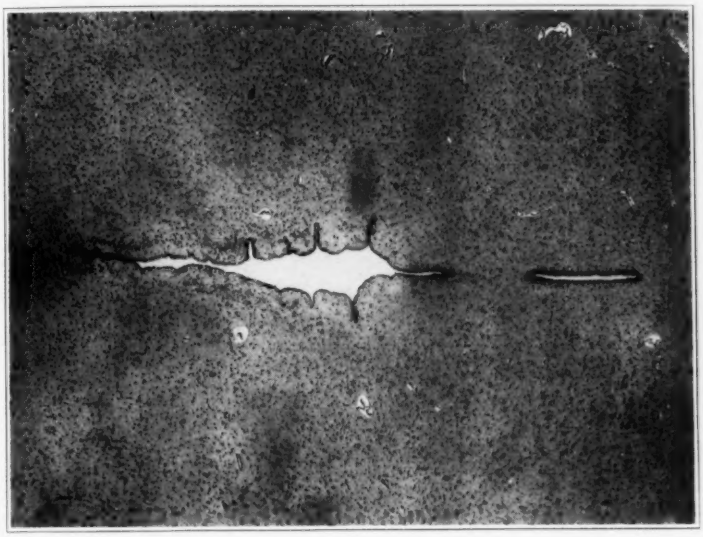

Fig. 5.—Congenitally narrow aqueduct of Sylvius with a band of glial tissue dividing the canal into two parts. Hematoxylin and eosin; × 18.

and thereby interfering with the patency of the aqueduct of Sylvius, to make this condition a reasonable possibility to consider in the diagnosis of the cause of internal hydrocephalus of the obstructive type.

Case 5.—A woman, aged 18, was brought to the Mayo Clinic on June 18, 1931, because of headaches for about six weeks. She had presumably been well until six weeks before coming to the clinic, when frontal headaches began to occur almost every day, and awakened her at night. They were usually severe, and were associated with blurring of vision, diplopia, vertigo and vomiting. Four weeks before we saw her, vision became blurred and she saw double. Ten days before examination there were transient numbness in the right arm and photophobia. One week before examination, strabismus was noted.

The patient was overnourished, weighing 142 pounds (64.4 Kg.); her blood pressure was 110 systolic and 70 diastolic. Vision was 6/12 in the right eye and

6/15 in the left eye; the pupils were equal; they reacted poorly to light, but accommodation was normal. Ocular movements and the perimetric fields were normal. There were bilateral, acute choked disks of 3 diopters and a concomitant convergent strabismus. Roentgenograms of the thorax were apparently normal; roentgenograms of the head gave considerable evidence of increased intracranial pressure.

A ventriculogram was made on June 23, 1931, which revealed bilateral internal hydrocephalus, with a dilated third ventricle; the fourth ventricle was not seen. Neurologic examination gave entirely negative results. On June 24, 1931, cerebellar exploration was made, which disclosed marked increased intracranial pressure, with herniation of the cerebellar lobe, but no tumor. The patient died on June 27, 1931.

At necropsy, all the organs other than the brain were normal, except that there were a chronic active tubercle, 2 cm. in diameter, in the lower lobe of the right lung, and a caseous tubercle, 1 by 2 cm., in one of the lymph nodes at the hilus of the right lung. There was no other evidence of tuberculosis. Microscopically, the pulmonary and the hilar node proved to be the site of chronic tuberculosis, and contained tubercles, giant cells, necrotic tissue and some precipitated calcium. After removal, the brain was seen to have flattened convolutions, and cerebrospinal fluid was absent from the subarachnoid space. There were no acute or chronic inflammatory processes or tubercles in the meninges. On cross-section, there was internal hydrocephalus (graded 2+) affecting the lateral and third ventricles, but none of the fourth ventricle. Sections across the midbrain disclosed a tubercle, 1 cm. in diameter, involving the mesial portion of the right superior colliculus, and extending mesially so as to compress the aqueduct of Sylvius and obstruct its lumen (fig. 6). The ependyma of the ventricular walls was uniform; there were no granular ependymitis and no tubercles, and the choroid plexuses were normal; there was no inflammation. There was no other tubercle, and no signs of tuberculosis were present in the substance of the brain. Microscopic study confirmed this, for the meninges were normal, and no inflammatory reaction was present in any part of the central nervous system except the midbrain. Sections across the superior colliculus and aqueduct of Sylvius disclosed that this canal was much compressed by a tubercle projecting into it from the right lateral wall. This tubercle was typical, in that it contained giant cells and necrotic portions, and a fibroblastic reaction was evident in it (fig. 7). With the carbolfuchsin stain, tubercle bacilli were readily demonstrated. There was no reaction of the ependyma above or below the site of compression by the tubercle.

Comment.—For recent and excellent reviews of tuberculoma of the brain one might refer to the contributions of Ferris,[17] of Anderson,[18] of Van Wagenen[19] and of Knox.[20] From their conclusions it can be inferred that there is no special tendency of tuberculoma to invade any

17. Ferris, H. W.: Eight Cases of Tuberculoma of the Brain Found at Necropsy, J. A. M. A. **92**:1670 (May 18) 1929.

18. Anderson, F. N.: Tuberculoma of the Central Nervous System, Arch. Neurol. & Psychiat. **20**:354 (Aug.) 1928.

19. Van Wagenen, W. P.: Tuberculoma of the Brain, Arch. Neurol. & Psychiat. **17**:57 (Jan.) 1927.

20. Knox, J. H. M., Jr.: Lesions in Midbrain, Am. J. Dis. Child. **20**:436 (Nov.) 1920.

one portion of the brain. The older authors lay stress on the cerebellum as being particularly vulnerable, and all but 3 of Van Wagenen's 14 patients had a tuberculoma in the cerebellum. In Anderson's large series of 120 cases reviewed from the literature on tuberculoma of the

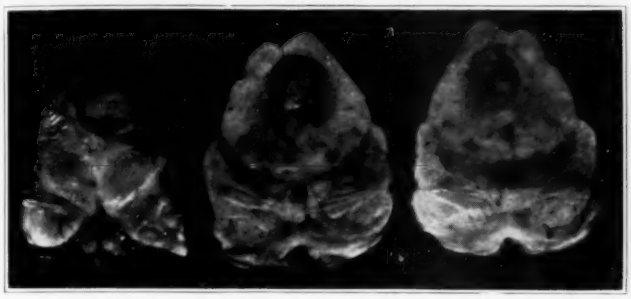

Fig. 6.—Tuberculoma in the midbrain, compressing and occluding the aqueduct of Sylvius. This was the only tubercle in the central nervous system. Meningitis was present.

Fig. 7.—Tuberculoma compressing the aqueduct of Sylvius. The tuberculoma is made up of tubercles, giant cells, fibroblastic reaction and areas of necrosis. Calcium precipitation is not present. Hematoxylin and eosin; × 35.

brain, however, there were lesions in all parts of the brain, occurring in the frontal lobes with greatest frequency. As far as involvement of the midbrain is concerned, in neither Anderson's nor Van Wagenen's series was such a situation mentioned. Anderson's 120 cases disclosed

involvement of the mesencephalon in 13 instances (10.8 per cent). In Starr's [21] series of 152 cases, 16 tuberculomas (10.5 per cent) were situated in the midbrain. Three-fourths of the total series reported by Anderson concerned solitary tubercles, and Van Wagenen claimed that in most of his cases the tuberculous tumor was also solitary. Nevertheless, among 8 cases reported by Ferris, there were multiple lesions in 7. There is, therefore, no constancy in either the situation or the multiplicity of tuberculous lesions in the body in cases of tuberculosis of the brain.

In recent years, complete records of single cases of mesencephalic tubercle have been published by Knox, by Caussade, Cornil and Girard [22] and by Nissen,[23] and the characteristic symptoms have been outlined. In these cases the dorsum of the midbrain was particularly involved. Primarily, therefore, the syndrome of Nothnagel was the outstanding clinical feature, consisting of unilateral or bilateral oculomotor palsy, with ataxia of the cerebellar type. Symptoms of increased intracranial pressure came later, and could be interpreted as being due either to compression of the aqueduct of Sylvius or to tuberculous meningitis that usually ends the clinical course of the disease. This meningitis may also mark the beginning of the clinical course, and may lead to a fatal termination, with an unsuspected tuberculoma being found after death.

Case 5 is therefore unusual in that the tuberculous lesion was more nearly in the center of the midbrain, occluded the aqueduct early, and caused death before signs of destruction of the mesencephalic structures were in evidence or meningitis appeared. From the beginning to the end of the disease, the main features were those of internal hydrocephalus from occlusion of the pathways of cerebrospinal fluid, and differed little from those in the cases described. The only localizing signs were those of Argyll Robertson pupil, already demonstrated by Wilson [24] as a possible indication of disease of the midbrain. Ventriculograms merely corroborated the clinical impression of internal hydrocephalus, and allowed the situation of the obstruction to be identified as being located somewhere caudal to the third ventricle. To make the diagnosis more difficult, there were no clinical signs of tuberculosis revealed in either history or examination, and the pulmonary lesions were such as to be inconspicuous in the roentgenograms of the thorax.

21. Starr, M. A.: Organic Nervous Diseases, New York, Lea Brothers & Company, 1903, p. 585.

22. Caussade, L.; Cornil, L., and Girard, J.: Tuberculome des tubercules quadrijumeaux gauches, Rev. neurol. **1**:83, 1928.

23. Nissen, W.: Zur Klinik der Tumoren der Vierhügelgegend nebst Bemerkungen zu ihrer Differentialdiagnose mit Kleinhirngeschwülststen, Jahrb. f. Kinderh. **54**:618, 1901.

24. Wilson, S. A. K., and Gerstle, Mark, Jr.: The Argyll Robertson Sign in Mesencephalic Tumors, Arch. Neurol. & Psychiat. **22**:9 (July) 1929.

At necropsy there were no other evidences of tuberculosis than the caseous lymph nodes at the hilus and a small tubercle in the lower lobe of the right lung that easily could have been missed at necropsy. It is doubtful if the correct diagnosis could have been made before death, and clinically the case differed little from the other cases described.

New growths of the brain vary tremendously in the size they reach before they can cause symptoms. The frontal lobe of the cerebral hemisphere may be the seat of a relatively enormous tumor, with but few signs to indicate its presence; by contrast, the midbrain tolerates invasion by a tumor extremely poorly. Surrounding the aqueduct are highly important masses of cells and nerve-fiber tracts, and injury thereto is promptly responded to by symptoms possessing localizing signs in a high degree. The majority of tumors arising in this region give characteristic symptoms, and there seems to be a predilection for the roof structures of the midbrain. Following the work of von Frankl-Hockwart,[25] Foerster,[26] Horrax and Bailey,[27] Globus and Silbert,[28] Glaser,[29] Harris and Cairns [30] and others, the syndrome of tumors arising from the pineal gland or lamina quadrigemina has been well established. The more constant features of this syndrome are represented by oculomotor palsy, bilateral spasticity and signs of implication of the cerebellar mechanism or tracts. Inevitably the tumor later presses on the aqueduct and signs of increased pressure are added to the symptoms named. However, when tumors arise in the more immediate vicinity of the aqueduct, invade its lumen and lead to early hydrocephalus, death may ensue before any localizing signs appear. Cushing [31] described a case in which gross examination at necropsy revealed internal hydrocephalus that was thought to be of inflammatory origin and was so classified. Investigation repeated years later, carried on by

25. von Frankl-Hochwart, L.: Ueber Diagnose der Zirbeldrüsentumoren, Deutsche Ztschr. f. Nervenh. **37**:455 (Oct. 21) 1909.

26. Foerster, O.: Das operative Vorgehen bei Tumoren der Vierhügelgegend, Wien. klin. Wchnschr. **41**:986 (July 12) 1928.

27. Horrax, Gilbert, and Bailey, Percival: Tumors of the Pineal Body, Arch. Neurol. & Psychiat. **13**:423 (April) 1925.

28. Globus, J. H.: Tumors of the Quadrigeminate Plate. A Clinico-Anatomic Study of Seven Cases, Arch. Ophth. **5**:418 (March) 1931. Globus, J. H., and Silbert, Samuel: Pinealomas, Arch. Neurol. & Psychiat. **25**:937 (May) 1931.

29. Glaser, M. A.: Tumors of the Pineal Corpora Quadrigemina and Third Ventricle, the Inter-Relationship of Their Syndromes and Their Surgical Treatment, Brain **52**:226 (July) 1929.

30. Harris, Wilfred, and Cairns, Hugh: Diagnosis and Treatment of Pineal Tumors with Report of a Case, Lancet **1**:3 (Jan. 2) 1932.

31. Cushing, Harvey: Notes on a Series of Intracranial Tumors and Conditions Simulating Them, Arch. Neurol. & Psychiat. **10**:605 (Dec.) 1923.

means of serial sections of the midbrain and by microscopic examination, demonstrated the existence of a minute subependymal glioma arising in the floor of the aqueduct, blocking it and leading to hydrocephalus and death. Orton has also given a detailed description of a small astrocytoma arising beneath the aqueduct, and 2 similar cases were described by us [3] in a previous contribution. Lest they be considered of too extreme rarity, an additional example of invasion of the aqueduct by tumor may be cited.

Case 6.—A boy, aged 12, was brought to the Mayo Clinic on March 31, 1930, because of headaches. Ten months before, he commenced to have attacks of

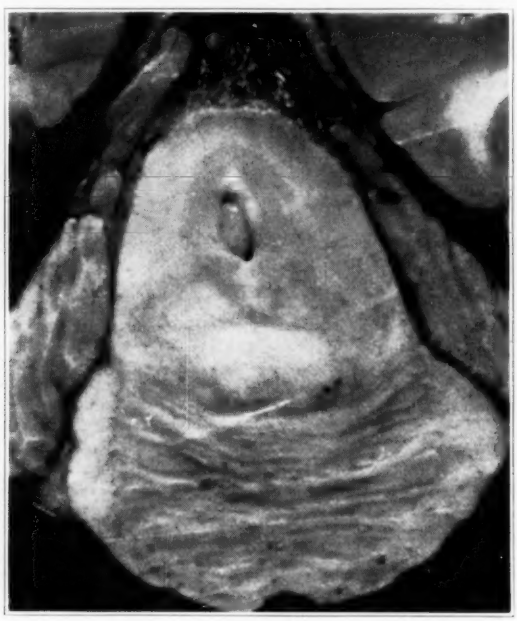

Fig. 8.—Posterior end of the tumor filling the aqueduct of Sylvius.

parieto-occipital headache, with vomiting and drowsiness. The headaches appeared suddenly, lasted about from eight to twelve hours and were associated with blurring of vision. Three weeks before his registration, they had become continuous. His handwriting had become less distinct.

The boy was well developed and well nourished, weighing 78 pounds (35.4 Kg.). He had marked horizontal nystagmus. All tendon reflexes were diminished. There were a very slight degree of ataxia in walking and incoordination of the hands in performing finer movements. The plantar reflexes were extensor on both sides, and there was a "cracked pot" note on percussion of the skull. Ocular examination disclosed bilateral choked disks, on the right, of 3 diopters, and on the left, of from 1 to 2 diopters. There was no ocular palsy. Roentgenograms of the skull disclosed marked increase of intracranial pressure, with erosion of the clinoid processes on the floor of the sella turcica. Roentgenograms of the thorax were

normal. A diagnosis was made of internal hydrocephalus, the suspected cause of which was cerebellar tumor.

On April 3, 1930, bilateral cerebellar exploration and decompression were done. Markedly increased intracranial tension was found, but no tumor. Convalescence was satisfactory, and roentgen treatment was given ten days later. Three days following this, vomiting recurred, and the patient became comatose and remained so for two weeks. His condition improved, and he responded to stimuli; then he had a violent convulsion, and died on April 6, 1930.

At necropsy, the brain showed the usual signs of increased intracranial pressure, such as absence of cerebrospinal fluid from the subarachnoid space, flattening of the convolutions and erosion of the posterior clinoid processes and of the floor of the sella turcica. After fixation, the brain was cut by coronal section, and dilatation of the lateral and anterior parts of the third ventricle was present. A smooth, rounded tumor was attached to the massa intermedia and right thalamus. This tumor extended backward into the anterior half of the midbrain and projected into the aqueduct of Sylvius (fig. 8). The tumor was firm and uniform throughout, and hemorrhages or regions of necrosis were not present. The tumor infiltrated the surrounding brain, and there was no sharp line of demarcation. It grew from, or was attached to, the right superior colliculus, and its posterior end was a small, rounded mass growing in the lumen of the aqueduct of Sylvius. Microscopic study disclosed that the tumor was an astrocytoma, made up of well differentiated glial cells, with numerous neuroglia fibrils. No primitive glia cells were present, and when Cajal's gold chloride and sublimate method of preparation were used many of the tumor cells were seen to have long processes attached to adjacent blood vessels. Microscopic study of the ventricles disclosed that there was no ependymitis or proliferation of the subependymal glia.

Comment.—Such localizing signs as were present in this case could have been interpreted as being due to the severe internal hydrocephalus that was known to exist or to cerebellar injury. Two of the triad of signs mentioned by Horrax and Bailey were present, namely, ataxia and a bilateral Babinski sign. These in themselves are not sufficiently diagnostic without being associated with the third and most important sign of invasion of the lamina quadrigemina, namely, disturbance of the apparatus of the third nerve. Actually, such signs as ataxia, incoordination, nystagmus and a bilateral Babinski sign may appear in any case of severe internal hydrocephalus, irrespective of causes. No blame can be assumed for the mistaken exploration of the cerebellum, for again and again various authors have commented on the difficulty in differentiating between cerebellar tumors and those invading or compressing the mesencephalon. In the final analysis the case represents merely severe internal hydrocephalus due to a tumor arising near the oral end of the aqueduct, growing into the canal and obstructing its lumen. Clinically, the case differed little from the others reported in this paper.

SUMMARY AND CONCLUSIONS

Six cases have been described in which some chronic pathologic process led to progressive narrowing of the aqueduct of Sylvius. In five, the stenosis had led to urgent clinical symptoms demanding diag-

nosis and therapeutic relief. Unfortunately, in these cases there was almost a monotonous similarity in clinical symptoms, even though diverse pathologic processes were present, each acting as a cause of illness and ultimate death. Essentially the clinical picture was one of chronic internal hydrocephalus, with all the evidence of increased intracranial pressure in the form of headaches, vomiting and visual disturbance. Necropsy was performed in each case, and revealed pathologic changes, including syphilis, tuberculosis and new growths. Chronic proliferative processes in the periaqueductal neuroglia were also featured, some presumably of inflammatory or toxic origin, and others possibly due to developmental error. One case is recorded in which narrowing of the aqueduct had occurred owing to congenital malformation of this channel. The ages of the patients ranged between 6 and 35 years.

The differential diagnosis between occlusion or narrowing of the aqueduct and tumors filling the fourth ventricle is always difficult. Ventriculography does not do any more than establish the existence of internal hydrocephalus of the lateral and third ventricles. It may suggest the possibility of occlusion of the aqueduct from causes operating in the immediate vicinity of the canal, but tumors so operating, which may be capable of surgical removal, cannot be excluded. Nevertheless, the study indicates the frequent existence of chronic pathologic processes in the tissues surrounding the aqueduct of Sylvius and the marked variability of essential causes, all of which produce the same physiologic disturbance and inevitable clinical result.

Granulomatous processes and new growths are more readily understood and recognized pathologically. There remains, however, a definite group of cases in which the pathologic changes are chronic proliferation of the glia surrounding the aqueduct. These cases are not so readily interpreted and understood, and therefore constitute by far the more interesting part of the material of this study. Chronic ependymitis, periaqueductal gliosis and congenital narrowing of the aqueduct represent minutiae, much argued over but little comprehended, and yet deadly in their final effect. One type may grade imperceptibly into the other, and dogmatism as to the type is out of place. From prenatal life to the end of the natural span of life there is no period of existence in which one is immune. The aqueduct of Sylvius must always represent a highly vulnerable and delicate part of the bodily structure. Occlusion or stenosis of this tiny canal occurs frequently enough in infancy and childhood to remove a definite share of the population. As has been seen in this study, the condition may also occur, although less frequently, in older persons; that it does not occur more often is remarkable.

DISCUSSION

DR. LEON H. CORNWALL, New York: Drs. Parker and Kernohan have given an excellent résumé of the condition under discussion and have covered in detail the various theories that have been advanced for the explanation of this condition. Quite properly they emphasize the difficulty in diagnosis that is often encountered in these cases and the similarity of the symptomatology to that of tumors of the posterior fossa.

In their discussion of the two main causes that have been advanced to explain subependymal gliosis, that is, developmental and postinflammatory conditions, the authors express their opinion that in a few cases at least the origin is due to developmental error similar to that which is recognized as occurring in the central canal of the spinal cord. With this conclusion I am in hearty accord, and I believe that the fourth case reported in this paper lends support to that view.

DR. HENRY R. VIETS, Boston: If one limits the cases of stenosis of the aqueduct of Sylvius to those occurring in adults without previous history of meningitis, or without signs of tumor of the brain, the condition is extremely rare. The following report from the records of the Massachusetts General Hospital gives the essential facts in regard to a patient with a similar condition, showing many of the signs and symptoms indicated by the authors.

E. J. F., aged 22, entered the hospital on April 1, 1931, with a history of complete blindness of four and a half months' duration. About Nov. 1, 1930, he noticed that his eyesight was failing; by November 12 his vision was so much blurred that he could barely distinguish objects; the next morning, he was just able to distinguish between light and dark, and by December 1 his vision was completely gone. At no time did he have headache, nor had he vomited; in fact, he was entirely free from symptoms except for blindness. His history was otherwise irrelevant.

Neurologic examination gave surprisingly negative results, but both fundi showed well marked secondary optic atrophy with pale, blurred disks, without definite elevation. There were slight paresthesia of the right side of the face and paralysis of upward movement of the eyes, equal on both sides and well marked. In addition, both arms showed some ataxia, tremor and asynergy, more on the right side, and there was a tendency to fall backward in walking or standing. The deep reflexes were lively, and the Babinski sign was sometimes present on the right side. The pupils reacted to light in spite of the total blindness.

Roentgen examination of the skull showed the convolutional markings to be unusually prominent, with the sutures widely separated. The findings were those of advanced chronic increased intracranial pressure.

Cerebellar exploration on April 13, 1931, by Dr. John S. Hodgson, revealed the following: There was no evident pressure cone, and the cerebellum was high rather than low. The cistern appeared to be of normal size, and the cerebellar hemispheres were not enlarged and lay in their usual position. The fourth ventricle was about normal in size. No tumor was observed. An unusually good view of the upper part of the fourth ventricle was obtained, but there was no evidence of tumor. A fine catheter was then passed up through the fourth ventricle into the aqueduct of Sylvius, and it met with obstruction about ¾ inch (1.9 cm.) beyond the opening of the aqueduct. During this time it seemed as though there was less than the normal flow of cerebrospinal fluid from the ventricles. Jugular compression failed to bring down additional fluid from above.

The patient died of erysipelas of the face and secondary meningitis on May 22, 1931.

Necropsy, performed on May 23, 1931, six and a half hours post mortem, by Dr. Charles S. Kubik, showed: There was a large amount of thick, yellowish exudate in the arachnoid space of the basilar cistern, the base of the pons and the medulla, and to a lesser degree over the upper and lower surfaces of both cerebellar lobes. The convolutions were flat. There was slight herniation of the cerebellar lobes into the foramen magnum; no masses were felt; the cerebral and cerebellar hemispheres were of equal size on the two sides.

On section of the brain after fixation, the lateral and third ventricles were enormously dilated (capacity 300 cc.). The fourth ventricle was not enlarged and appeared smaller than is normal. The aqueduct of Sylvius did not transmit water, and on section of the midbrain at the level of the inferior quadrigeminal bodies, a small mass of pale grayish, soft, finely granular material was found, which extended 2 or 3 mm. along the canal. No sharply defined margin could be made out. The midbrain was not enlarged at any point. Above the level of the lesion the aqueduct was moderately enlarged, and the ependyma was dotted with minute hemorrhages the size of pinpoints. The pineal gland was about normal in size. Serial sections of the cerebellum, 0.5 cm. in width, did not disclose any tumor.

On microscopic examination, there was a cellular exudate in the subarachnoid space, most extensive over the medulla, where it also involved the ependyma and choroid plexus of the lateral recesses and ependyma and subependymal tissue of the floor of the fourth ventricle. It was comparatively slight over sections taken from the cerebrum and cerebellum. The exudate was composed of lymphocytes, polymorphonuclear cells, plasma cells and endothelial cells. In places over the medulla it consisted of two more or less distinct layers, an inner one composed chiefly of lymphocytes and plasma cells and an outer one in which most of the cells were polymorphonuclears.

Nerve roots and vessel walls were infiltrated with the various types of inflammatory cells, which in some cases were found in large numbers between the intima and media. Some of the vessels were thrombosed. Several giant cells were noted, and one of these contained an unstained circular or spiral body. The exudate extended along the vessels into the medulla for a considerable distance.

Sections through the obstructed portion of the aqueduct revealed a slitlike opening less than 1 mm. long at its smallest point.

The surrounding tissues consisted of dense fibrous glia infiltrated with lymphocytes, polymorphonuclears and leukocytes. No trace of the ependymal lining was seen. The floor of the fourth ventricle exhibited a similar picture.

DR. H. L. PARKER: I think that these cases occur a little more frequently than is realized, and they present an extremely difficult diagnostic problem.

HOUR-GLASS TUMORS OF THE SPINE

HOWARD C. NAFFZIGER, M.D.
AND
HOWARD A. BROWN, M.D.
SAN FRANCISCO

In the cases of tumor of the spinal cord presented here we are including those which have an intraspinal portion, connected by a small neck with an extraspinal enlargement. While most frequently the communication is through an intervertebral foramen, it may occur through the interlaminal spaces. Intraspinal tumors which are both intradural and extradural, connected by a small constricted stalk through the dura, are placed also in this classification. Destructive metastatic growths are not included in this series.

Hour-glass tumors may appear in any location from the atlas to the coccyx. They have received little consideration in the past, and it is the current impression that they are infrequent. Our particular reason for reporting this group is that these tumors appear with such frequency in our patients with compression of the spinal cord from a tumor that the possibility of an hour-glass tumor always must be considered.

The clinical reports of the subject usually have been made because the surgeon, operating on account of compression of the spinal cord, found an intraspinal tumor which extended through an intervertebral foramen. Heuer [1] reported on this subject in 1929. He was able to collect fifty-nine cases from the literature, to which he added three from his own experience and two from personal communications from other surgeons. On the University of California service, fifteen such patients have been operated on, and the subsequent course has been followed. These cases are reported here.

An intraspinal operation accomplishes no more than the removal of the intraspinal portion of the tumor. Recurrence of the growth, therefore, is expected. The character and nature of many of the hour-glass tumors are such that an extension of the operation or a second-stage operation often will permit a complete removal of the extravertebral portion as well, and it is only by following such a plan that permanent cure may be achieved. It seems unquestionable that many of these

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Read at the Fifty-Eighth Annual Meeting of the American Neurological Association, Atlantic City, N. J., June 6, 1932.

1. Heuer, G. J.: The So-Called Hour-Glass Tumors of the Spine, Arch. Surg. **18**:935 (April) 1929.

intraspinal tumors have recurred, not because they are malignant, but because, although they are benign, removal has been incomplete owing to the surgeon's unfamiliarity with the fact that the extraspinal portion ordinarily is encapsulated and that its radical removal may be accomplished.

There are, of course, certain malignant tumors of the hour-glass type, namely, the sarcomas; but it may be added that this group is relatively benign because most of these tumors do not metastasize. However, the majority of hour-glass tumors are benign and have origin in the dura, leptomeninges, nerve roots or ganglia. Certain tumors arise from the sympathetic nervous system; the minority arise from cartilage, fascia, ligaments or other tissues in the neighborhood.

Since Heuer's report, Aguilar [2] reported two hour-glass tumors of the dorsal spine, both round cell sarcomas; Guleke [3] reported one low cervical chondroma and one lumbar growth which he termed a "sympaticoblastoma." Including these cases, the total number reported is sixty-eight; our cases bring the number to eighty-two.[4] The incidence of these tumors in our experience leads us to believe that a more careful study of other tumor series would add many more.

Of the cases reported by Heuer, eighteen occurred in the cervical region, thirty-seven in the dorsal region and eight in the lumbosacral region; there was one case of multiple hour-glass tumors.

One might expect that a valuable diagnostic point would be the presence of early and persistent root symptoms. This is borne out by the case reports. The neurologist should bear in mind that in cases of hour-glass tumor the intervertebral foramina often are enlarged, and that this is demonstrable by roentgenograms. In other cases an erosion of the spinous processes or the lamina may be seen. Hour-glass tumors may be diagnosed frequently by such study, though in the past, attention has been called to them chiefly by finding an intrathoracic tumor on roentgen examination or by noting a palpable cervical growth.

The surgeon must always have in mind the possibility of such lesions. Ordinarily, the compression of the cord must receive first attention, but, not infrequently, this operation may be extended to remove the extraspinal portion of the tumor also. In other cases, a second-stage operation will permit a total removal of the growth and prevent its recurrence.

It is interesting that occasionally thoracic tumors have been removed without being recognized as hour-glass tumors at the time of operation.

2. Gonzalez-Aguilar, J.: Histopathology of "Hour-Glass" Sarcomas: Case, Rev. méd. de Barcelona **11**:126 (Feb.) 1929.

3. Guleke, N.: Diagnosis and Etiology of Hour-Glass Tumors of the Spine, Arch. f. klin. Chir. **161**:710, 1930.

4. Case 1 of our series was reported by Heuer.

In such instances a hydrothorax may appear, and the clear fluid may not be recognized as cerebrospinal fluid that has escaped from the subarachnoid space through a dural tear occurring at the time of the removal of the tumor. With clear, colorless fluid in the chest, such a source must be kept in mind.

REPORT OF CASES

CASE 1.—*Pain in the chest for three years and signs of compression of the cord for two months. Removal of an intravertebral tumor and later partial removal of a thoracic tumor; recovery.*

History.—Mr. F. N., aged 25, on entry to the hospital, on Nov. 9, 1925, gave a history of periodic pains in the right side of the chest posteriorly for about three years. The pain was aggravated by exertion or by bending over. There had been little change in the condition until two months before admission, when he noticed an upward-spreading numbness of both feet, which soon was followed by stiffness and weakness of the legs. In a month he walked with great difficulty, and shortly thereafter lost the ability to void urine voluntarily. Recently, he had complained also of a persistent, bandlike sensation about the lower part of the chest.

Examination.—There was dulness over the right side of the chest posteriorly in the middorsal region. The upper extremities were normal. The legs were moderately spastic and showed marked bilateral weakness, which was more evident on the right side. The reflexes of the lower extremities were increased but equal; the abdominal reflexes were sluggish, and the Oppenheim reflex was positive bilaterally. The patient had an ataxic gait, with a wide base and dragging feet. Sensation was diminished below a horizontal line at the level of the ensiform cartilage, and there was a narrow band of hyperesthesia just above this level, extending to the fourth dorsal segment.

Spinal puncture revealed an almost complete block. Roentgen examination showed a rounded mass in the right side of the chest, extending inward from the space between the fifth and sixth ribs on the right side posteriorly, with erosion of the transverse process of the fifth dorsal vertebra and the superior margins of the sixth rib.

Operation.—On November 9, a laminectomy was done. Beneath the fifth and sixth dorsal laminae was a lentil-shaped tumor; it was dark blue and was rounded at both ends; it was about 3 cm. in length, and covered the entire dorsal aspect of the cord, but converged to a pedicle which passed through the intervertebral foramen between the fifth and sixth dorsal vertebrae on the right side. The posterior half of the intervertebral foramen was removed; the tumor was cleaved from the dura, which was much dented, and one sensory root was removed as well. A soft, sago-like material was curetted out of the intervertebral foramen, and eight Baer radium tubes were inserted into the immediate vicinity of the foramen outside the vertebral canal. The pathologic report was that the tumor was an osteochondroma.

Course.—There was improvement in the legs thereafter, and control of the sphincter returned to normal in a short time; all forms of sensation showed improvement within the next month.

Second Operation.—On December 13, the thoracic portion of the tumor was approached by an incision over the posterior aspect of the chest a short distance to the right of the midline. The fourth, fifth and sixth ribs were removed from their dorsal attachments; below the fifth rib was a tumor mass. The capsule was

opened, and the contents were found to be soft, friable and gelatinous; a great deal of this material was curetted out. The tumor extended about 6 cm. laterally from the sixth dorsal spine and seemed to travel across the midline on the ventral aspect of the vertebra, displacing the vena cava. In trying to remove the capsule, the parietal pleura was opened, and a small amount of air entered the pleural cavity. The pleura was sutured, and the tumor cavity then was packed with 50 per cent alcohol gauze, and a catheter was introduced into the center of it. The pathologic report again was that the tumor was an osteochondroma.

Subsequent Course.—Convalescence was satisfactory, and slight drainage persisted only for a short time. The patient was able to walk well without assistance, had lost all of the bandlike sensations and was improving steadily. Roentgen examination, at the time of discharge from the hospital, showed no evidence of the mediastinal mass. When last heard from, in 1930, there had been no recurrence of pressure symptoms.

CASE 2.—*Slowly advancing signs of compression of the cord. Removal of an intradural and extradural tumor. Temporary improvement, followed by a recurrence of symptoms necessitating the removal of an intravertebral and paravertebral tumor; recovery.*

History.—Mrs. J. T. W., aged 44, seven years before entering the hospital in July, 1928, had noted transient numbness of the left arm and an occasional pain low in the cervical region. There was no appreciable advance until July, 1927, when she noticed pain in the left shoulder and progressive numbness of the left hand, chiefly on the ulnar side. In January, 1928, she noticed difficulty in using the left leg and complained of stiffness of both knees. The motor weakness increased steadily, and she had been unable to walk for ten days. The weakness of the left leg was much greater than that of the right. Urgency and frequency of urination, as well as constipation, had been present for five months. In addition, she complained of constant pain in the left arm and hand, which was increased by coughing or straining, a bandlike sensation extending around the thorax beneath the breasts and slight numbness of the right little finger.

Examination.—No palpable masses were present in the cervical region. There was great weakness of the left arm and leg, with spasticity throughout, and the muscles supplied by the eighth cervical and first dorsal segments showed marked atrophy. The right arm and leg were moderately weak, but exhibited only slight spasticity. Sensory examination revealed anesthesia over the eighth cervical and first dorsal segments on the left, with a marked decrease in all sensations below that level; the eighth cervical segment was the upper level on the right side also, with loss of pain, touch and temperature down to the sixth dorsal segment and moderate sensory impairment below that level. The reflexes of the arm were active and equal; the ankle and knee jerks were sluggish, but equal; there was no abdominal reflex on the left, and the Babinski reflex was positive on that side.

Spinal puncture revealed evidence of partial block, increased protein and globulin and clear fluid. Roentgen examination of the cervical and dorsal spine gave negative results, except for slight arthritic changes.

Operation.—Cervical laminectomy was done on Aug. 8, 1928. An intradural tumor mass, which surrounded the sixth spinal root and caused compression of the cord, was found on the left anterolateral aspect of the cord. The tumor was firm and reddish, and was attached to the dura laterally by a broad sessile base. It was separated from the cord without difficulty, and was removed with a portion of dura at its attachment. It then was seen that the tumor extended through the intervertebral foramen with the sixth cervical root. The foramen was

curetted out as cleanly as possible, and the dura was left open. The tumor was diagnosed as a neurofibroma, probably arising from the sixth cervical root.

Course.—Rapid improvement followed the operation, and the patient was able to walk with help a month later. Four months after the operation, sensations were normal except over the area of the left eighth cervical and first dorsal segments; the patient was able to go up and down stairs; the sphincters functioned properly. Improvement continued slowly for some months, and the patient returned to work. However, by October, 1930, a recurrence of symptoms began, with increasing weakness of the left side, greater sensory impairment and spasmodic jerking of the lower extremities. About February, 1931, the patient noted a swelling of the left side of the neck. She returned to the hospital on March 9, 1931.

Examination on Readmission.—A smooth, hard, immobile, nonpulsating tumor, about 3 cm. in diameter, was palpable in the cervical region just above the left clavicle and behind the left sternocleidomastoid muscle. The motor and sensory involvement was essentially the same as on her first entry.

Second Operation.—On March 13, the old laminectomy wound was opened. The cord was found to be displaced to the right by a recurrence of the tumor in its original location. The tumor was separated from the cord, and additional dura was removed where the tumor was attached, following which the stalk was cut at the intervertebral foramen. The tumor was larger and apparently more cellular than at the first operation.

There was considerable improvement in sensation and power in the two weeks following operation.

Third Operation.—On April 7, the tumor in the cervical region was exposed, and a dissection carried down between the scalenus medius and scalenus anticus muscles. The fifth cervical root coursed over the anterior medial aspect of the tumor and gradually was freed from it. The sixth cervical root entered the tumor at the upper pole and emerged at its lower pole. The tumor was traced to the intervertebral foramen between the fifth and sixth cervical vertebrae, where the pedicle was cut, necessitating removal of the sixth root as well; residual tumor material about the foramen was coagulated with a Bovie unit. The interveterbal foramen was greatly enlarged. The tumor mass had a bluish, shiny capsule and was very firm. It was mobilized, the sixth root was severed distal to the tumor, and the entire mass was removed in one piece. The diagnosis of all specimens was neurofibroma.

Subsequent Course.—There was increased numbness from the fourth to the sixth cervical segments, and the biceps, brachialis anticus and brachioradialis muscles were without function. The patient was seen in February, 1932; she had had continuous improvement and was able to flex the forearm fairly well. Though there was almost no function in the biceps, flexion was accomplished by the supinator longus. The hand grip on the left equaled that on the right, and there was no atrophy. Sensation was normal except for the area supplied by the resected root. There was some residual weakness of the left leg, but the patient was able to walk several miles daily.

CASE 3.—*Pain in the left cervical region for one year with weakness and numbness of the left arm and leg, followed by involvement of the right side. Removal of intradural and extradural tumor; recovery.*

History.—Mrs. A. S., aged 37, entered the hospital on May 22, 1930, complaining of pain, of one year's duration, in the left cervical region and extending into the left arm and leg. Soon after the onset of pain, the left arm gradually became weak, and she had difficulty in feeling and grasping objects in that hand. About

February, 1930, the left leg began to feel numb and weak, and almost simultaneously the right arm and leg were involved. Pain was present periodically in both arms and legs, and occasionally involuntary jerking of the left arm occurred. These symptoms were aggravated by coughing. There was no disturbance of the sphincters.

Examination.—There were no visible or palpable masses in the cervical region. Strength was decreased in both arms and legs; this was more marked on the left side, on which the extremities were somewhat spastic. Sensation was decreased below the fifth cervical segment, the decrease in pain and temperature sensations being slightly greater on the right side. The deep reflexes were all increased on the left side; the abdominal reflexes were absent, and there was an abnormal

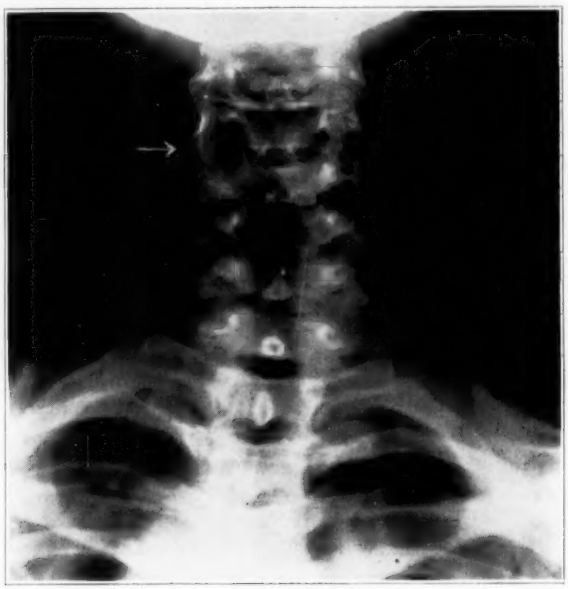

Fig. 1 (case 3).—Roentgenogram of the spine; the arrow indicates an enlarged intervertebral foramen between the third and fourth cervical vertebrae and erosion of the lamina of the fourth vertebra. The enlarged foramen, when accompanied by signs of compression of the cord at that level, is diagnostic of an hour-glass tumor.

plantar reflex on the left. The gait was unsteady, and the left leg was thrown to the side, with dragging of the toe.

On spinal puncture, the manometric responses were delayed, indicating a partial block. The fluid was clear and contained increased protein and globulin. Roentgen examinations of the cervical spine were reported as giving negative results.

Operation.—On May 26, a cervical laminectomy was done, revealing the cord dislocated backward and to the right, and without pulsation below the third cervical vertebra. When the dura was opened, a firm, red, meaty and vascular tumor was seen on the left side of the cord. It was difficult to mobilize. The dentate ligament passed through the tumor, which was attached to the dura by a broad base and extended down over an anterior root. It was removed in two pieces, one

with a block of dura at its lateral attachment, and the extradural portion came into view. The tumor then was seen to extend through an enlarged intervertebral foramen between the third and fourth cervical vertebrae; this was curetted out as far as possible. Microscopic examination showed a neurofibroma.

Course.—Recovery was rapid, and when the patient was discharged from the hospital two weeks later, there was no spinal block; sensation was almost normal, and her strength had improved remarkably.

Reexamination of the x-ray films after operation showed an enlarged intervertebral foramen between the third and fourth cervical vertebrae on the left, with erosion of adjacent bones and some erosion of the lamina of the fourth cervical vertebra. The erosion extended forward and involved part of the body of the same vertebra on the left (fig. 1).

On July 28, aside from a slight decrease in strength on the left side, the patient was entirely normal. In February, 1932, she had no complaints except for a little soreness about the operative area. The arms and legs were normal, and neurologic examination gave negative results. Examination of the neck revealed no palpable tumor.

CASE 4.—*Pain low in the back for five months, followed by paraplegia of rapid onset. Removal of an intravertebral and paravertebral tumor; progressive improvement.*

History.—Mr. P. C., aged 42, entered the hospital on March 5, 1932, with a history of pain low in the back dating from November, 1931. The pain began abruptly when he was doing heavy lifting and was of an aching character. It was persistent and was aggravated when he lay down. By January, 1932, he was unable to lie down at all. At this time coughing and straining caused a sharp, shooting pain which radiated from the back into both legs; at no time was there any suggestion of weakness or of paresthesias in the legs.

Examination.—There were some increase in the lumbar curve, a slight prominence of the fifth lumbar vertebral spine, moderate spasticity of the erector spinae muscles and slight limitation of motion. Roentgen examinations showed a slight posterior displacement of the fourth lumbar vertebra. The patient was placed in bed with traction applied to both legs in an attempt to correct the displacement. No relief was obtained by the traction, and six days later the patient first complained of numbness and weakness of both legs. These progressed rapidly, and by March 14 there was a sensory level at the twelfth dorsal segment, and he was unable to stand. There was no loss of sphincter control. He was transferred to the neurosurgical service.

On March 19, there was a rounded prominence to the right of the midline at the level of the spines of the eighth and ninth dorsal vertebrae; on palpation, a firm tumor, about 6 cm. in diameter, was felt. There was dulness to percussion over this immediate vicinity, with distant breath sounds. The upper extremities were normal; the lower extremities were slightly spastic and weak, the left side being more involved than the right. The reflexes were all hyperactive, more so on the right side than on the left. The upper abdominal reflexes were present; the lower abdominal and cremasteric reflexes were absent. There was decreased sensation over the parts below the eleventh dorsal segment. Spinal puncture revealed an almost complete block, with a marked increase of protein and globulin. X-ray plates of the dorsal spine showed enlargement of the foramen between the ninth and tenth dorsal vertebrae on the right, and a pressure deformity of the articular processes, both of these vertebrae and of their spinous processes (fig. 2). The tenth rib was narrowed, but no invasion of bone was seen. X-ray films of the chest revealed no evidence of an intrathoracic tumor.

Operation.—A dorsal laminectomy was performed on March 21. On incision through the fascia the tumor came into view. It was embedded in the muscles on both sides of the ninth and tenth dorsal spines. The mass on the right measured about 6 cm. in length by 3 cm. in diameter, while that on the left was perhaps half as large. These tumors were smooth, firm, yellowish and entirely encapsulated. Communication across the midline was seen as the muscles were separated. The tumor mass was so extensive that it was necessary to remove a part of it in order to continue the operation. Both the spinous processes and the laminae were eroded by pressure. As the lamina of the ninth dorsal vertebra was divided, it suddenly popped open, revealing an extradural tumor, about 2 cm. in length by 1 cm. in diameter, resting on the dorsal surface of the dura. As this was freed, it was found to be associated intimately with the

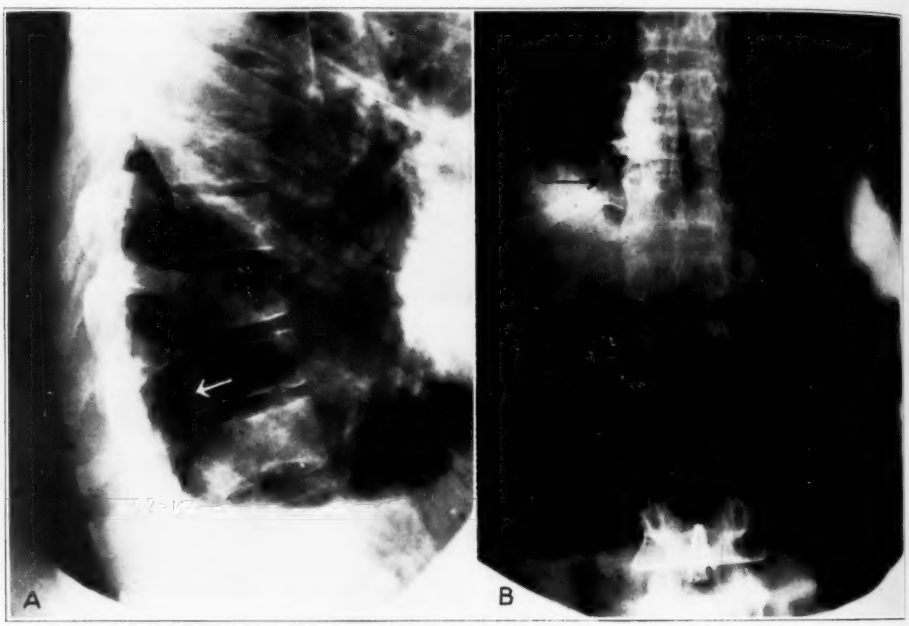

Fig. 2 (case 4).—*A*, lateral roentgenogram of the spine; the white arrow indicates an enlarged intervertebral foramen between the ninth and tenth dorsal vertebrae, and the black arrow a pressure deformity of the spinous processes. *B*, anteroposterior view of the same region pictured in *A*. This demonstrates the erosion of the articular processes of the ninth and tenth dorsal vertebrae as indicated by the arrow, and narrowing of the tenth rib.

dorsal root on the right side and to pass through the intervertebral foramen between the ninth and tenth dorsal vertebrae. Intradural exploration revealed no further masses. An extension on the right side was found between the ninth and tenth ribs and the tenth and eleventh ribs, entering the thoracic cavity. The ninth transverse process on the right was removed, and the mass in the thoracic cavity was extricated without damage to the pleura (figs. 3 and 4). Microscopic examination showed a neurofibroma.

Course.—The patient is making a rapid recovery from the paraplegia.

CASE 5.—*Weakness in both legs for seven years. Removal of an intravertebral and paravertebral tumor; no appreciable improvement. Death later from pneumonia.*

History.—Mrs. A. R., aged 61, entered the hospital on July 13, 1931, giving a history of the onset of hypesthesia in the left foot about seven years before; this was soon followed by changes of a similar character in the right foot; the numbness extended gradually and progressed to the level of the umbilicus. About six months after the sensory changes appeared, she noted that there was gradually increasing weakness, with rigidity and spasticity in both legs, and control

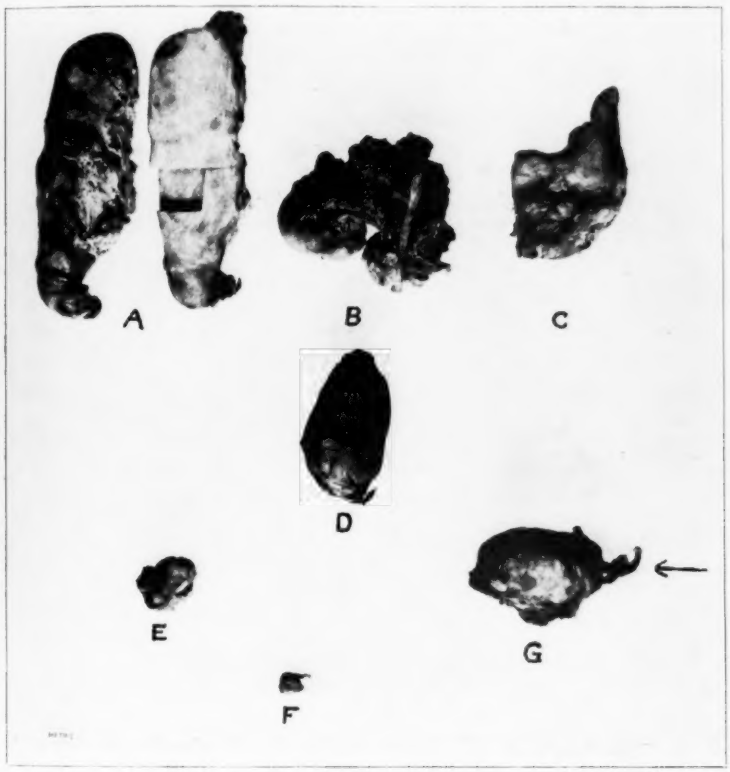

Fig. 3 (case 4).—Photographs of the tumor removed at operation (a neurofibroma). *A* indicates the portion in the muscles to the right of the spinous processes; *B* and *C*, portions lying between the spinous processes and to the left of the midline; *D*, the intravertebral tumor lying extradurally and compressing the dura and cord; *E* and *F*, small pieces projecting between the tenth and eleventh ribs into the thoracic cavity; *G*, the extension connected to the intravertebral tumor (*D*) through the intervertebral foramen, where it was associated intimately with the dorsal root, as shown by the arrow.

of the sphincters was lost. For the next six years there had been no appreciable change in these symptoms. In 1927, she first noticed that there was some prominence of the chest on the left side posteriorly, and that the spine in the

dorsal region was prominent, producing a kyphosis. At no time did she have any complaints referable to the respiratory apparatus.

Examination.—Over the left thoracic region posteriorly there were fulness and swelling; this area extended from the sixth to the twelfth dorsal spine and was approximately 12 cm. in diameter. It was compressible, but felt somewhat like a rubber ball; percussion elicited a dull sound, with a marked limitation of expansion, decreased fremitus and almost absent breath sounds. The right side of the chest showed signs of compensatory emphysema. There was scoliosis of the spine to the right in the middorsal region, with marked kyphosis. The heart was displaced toward the right, but otherwise seemed normal. Sensation was

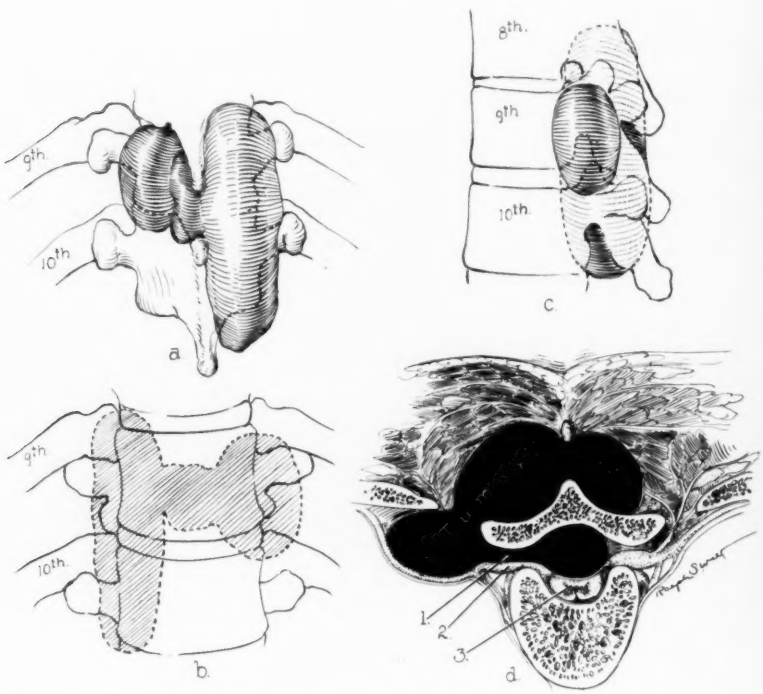

Fig. 4 (case 4).—Schematic representation of the tumor. In *a* is a dorsal view, showing the paravertebral tumor on each side of the midline, with a connecting stalk between the spinous processes; in *b*, a ventral view; in *c*, a lateral view from the left side; in *d*, a transverse section of the tumor, showing intraspinal and extraspinal portions of the tumor with hour-glass constriction at the intervertebral foramen: *1*, intervertebral foramen; *2*, dorsal nerve root; *3*, spinal cord.

absent from the tenth dorsal segment downward. The legs were both spastic. The reflexes were all hyperactive but were equal on the two sides; the abdominal reflexes were absent; the Babinski reflex was positive on both sides, as was the ankle clonus.

Spinal puncture revealed an incomplete block, with clear fluid. Roentgen examination demonstrated a large, oval tumor with a calcified shell, occupying almost the entire left side of the chest. There was loss of the left side of the

eighth, ninth and tenth vertebrae, with marked angulation of the spine to the right. On the left side, the eighth, ninth and tenth ribs were gone from a point 5 or 6 inches (12.7 or 15.2 cm.) lateral to the spine over to their spinal attachment (fig. 5).

Operation.—On July 16, a dorsal laminectomy was done. As the muscles were separated from the spinous process, red, meaty tumor tissue was seen just to the left of the seventh and eighth dorsal vertebrae. There was erosion of some of the spinous processes toward their bases. When the laminae were removed, more of this tissue was found compressing the dura. The cord was angulated at the level of the seventh and eighth dorsal spines as a result of the

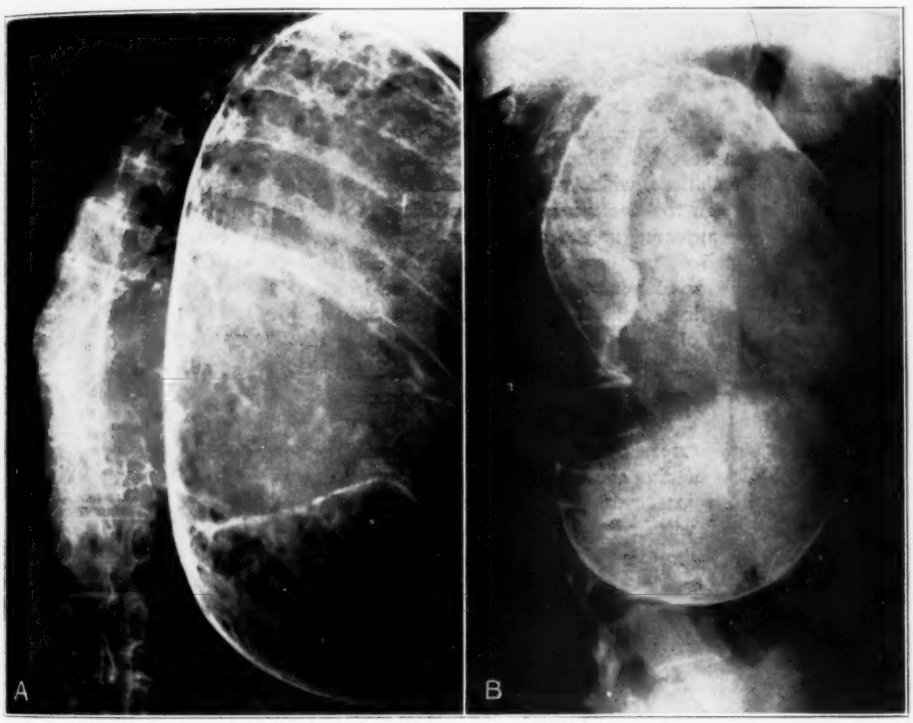

Fig. 5 (case 5).—*A*, anteroposterior roentgenogram of the thorax and spine, showing a large tumor of the chest with erosion and angulation of the vertebrae. This tumor is of tuberculous origin and is not associated with the hour-glass tumor at the level of angulation shown in the film. *B*, lateral view of the tumor shown in *A*.

vertebral scoliosis, but this angulation was insufficient in itself to cause compression of the cord. A large amount of tumor material was removed, but it was impossible to eradicate it completely because of its extension anteriorly. In retracting the muscles to the left, a smooth, hard, fibrous-looking capsule came into view, which represented the mesial and posterior aspects of the large tumor in the chest seen in the x-ray film. The wall was opened, and the central portion of the tumor was found to contain much yellowish myxomatous-looking fluid and degenerated tissue. A small section was removed for examination, and

the large tumor cavity was then closed. Microscopic examination of the spinal tumor showed a neurofibroma; the section from the thoracic tumor was reported to show merely fibrous tissue.

Course.—There was no improvement in the condition of the legs. Considering the long period of paralysis, this was not surprising. About two months after the operation, the patient died in another hospital from pulmonary complications which were diagnosed as pneumonia. Autopsy studies and inoculations into guinea-pigs proved the large tumor of the chest to be an old tuberculous process entirely separate from the hour-glass tumor involving the spinal cord.

CASE 6.—*Pain in the middorsal region for three years; numbness and weakness of the legs for one year, and inability to move the legs for three months. Removal of an intradural and extradural tumor; improvement.*

History.—Mr. W. L., aged 54, three years before entering the hospital on Oct. 17, 1931, had experienced sharp, shooting pains extending from the middorsal spine around the left side of the thorax; these later involved the right side as well, and extended down into the abdominal region; they persisted and increased in severity. One year before, the patient had noted numbness just below the umbilicus, which rapidly extended into the legs and feet; shortly afterward, he began to have weakness of both legs, which was progressive; sphincter involvement appeared at the same time. In June, 1931, an injection of iodized poppy seed oil 40 per cent was made, and a diagnosis of tumor established, but the patient refused operation. Since July, he had had a total paraplegia, complete sensory loss from the umbilicus down and loss of sexual power and of sphincter control.

Examination.—The patient had lost considerable weight and was in poor physical condition. There was a flaccid paraplegia with abolition of all lower reflexes and anesthesia below the ninth dorsal segment.

Spinal puncture showed a complete block and xanthochromic fluid. Roentgen examinations of the chest gave negative results for any thoracic tumor, and those of the spine revealed only the old iodized oil collected at the level of the seventh dorsal vertebra, from which point it did not shift.

Operation.—On October 22, a dorsal laminectomy was done, and an encapsulated intradural tumor was found at the level of the seventh dorsal vertebra, lying to the left of the cord and compressing it badly. Its appearance was white and firm near the cord, but red and meaty in its anterior and lateral extensions. Its location was subarachnoid, and, after opening this membrane, it was freed from the cord, mobilized and removed in two parts. The eighth dorsal root was involved and was resected with an area of dura to which the tumor was attached. After removal of the dura, further extension through the intervertebral foramen between the seventh and eighth dorsal vertebrae could be seen, and this was curetted out. Microscopic examination showed a dural endothelioma.

Course.—The pain diminished rapidly, but motor and sensory improvement was slow, because of the long period of complete paralysis before operation. Three months after operation the patient could move his legs slightly but could not walk, though spinal puncture did not show any evidence of block.

CASE 7.—*Pain low in the back for three years, followed by weakness first of the left leg and later of the right leg. Removal of an intradural and extradural tumor; recovery.*

History.—Mrs. C. L., aged 60, entered the hospital on March 13, 1929, with the complaint of marked weakness of the legs. Just prior to an operation for carcinoma of the uterus, in February, 1926, she had noticed periodic stinging

pains in the lumbar region, which were relieved by lying down. One month later, she was aware of weakness of the left leg, which followed closely by increasing numbness of the same member. By January, 1927, she could scarcely lift the left leg, and there were also progressive numbness and weakness of the right leg, necessitating the use of crutches by June. There was considerable discomfort from the jerking of both extremities; sensory changes had reached the umbilicus, and a tight bandlike sensation was present around the lower margin of the ribs. Walking, even with help, had been impossible for several months.

Examination.—Both legs were extremely weak, the left more so than the right, and sensation was decreased below the tenth dorsal segment. Vasomotor change was apparent at a level half way between the ensiform cartilage and the umbilicus. Below this point the skin was dry and scaly, while above the texture was normal. The reflexes were increased bilaterally but were more active in the left leg, while both sides exhibited Babinski reflexes and ankle clonus. There was tenderness to pressure over the region of the tenth dorsal spine.

Spinal puncture revealed xanthochromic fluid, with increased protein and globulin, and the Queckenstedt test revealed a complete block. Roentgen examinations gave negative results, except for arthritic changes.

Operation.—A dorsal laminectomy was done on March 20, 1929. The ninth dorsal lamina was destroyed partially by a red, meaty, extradural tumor, which was removed completely. It was evident that this extended intradurally as well, and when the dura was opened, an encapsulated tumor was seen to the left of the cord, compressing it badly. This portion was subarachnoid in position. It was freed and removed entirely. The microscopic picture was that of a dural endothelioma.

Course.—Recovery was satisfactory, and motor and sensory gain continued for many months. In May, 1930, the patient was almost without disability, and in April, 1932, she was in excellent condition and was working as domestic help.

CASE 8.—*Progressive weakness of the right arm for three years and recent weakness of the legs. Removal of an extradural tumor; improvement.*

History.—Mr. J. V., aged 55, three years before entry on June 18, 1931, had noticed some weakness of the muscles of the right hand, and a few months later pain developed in the region of the right scapula. The weakness gradually increased, involving the forearm and arm as well as the hand, and was accompanied by atrophy. Paresthesias, particularly along the right eighth cervical and first dorsal segmental distributions, had been persistent since the first few weeks of the symptoms, and the only numbness was in that region. In the month prior to admission to the hospital, there were slight weakness of both legs and minor paresthesias involving the left eighth cervical and first dorsal segmental distributions.

Examination.—Horner's syndrome was present on the right side. The right arm was weak and flaccid in all muscle groups, and there was considerable atrophy; the left arm showed slight weakness with some thenar atrophy. Both legs had less than normal power, the right being weaker than the left, and some degree of spasticity was present in both. There was impaired sensation from the fifth cervical to the ninth dorsal segment, with a greater loss over the right eighth cervical and first dorsal segments than elsewhere; otherwise, sensation was intact. The deep reflexes were all hyperactive, but were greater on the right than on the left, while the abdominal reflexes were equally sluggish on both sides. A Babinski reflex was present bilaterally, but was more pronounced on the right. Examination of the chest showed some limitation of movement

on the right side, and the breath sounds were harsh at the right apex. No masses were palpable in the cervical region.

Roentgen examinations of the chest and spine indicated a mass in the thoracic cavity at the right apex, and an enlarged intervertebral foramen between the seventh cervical and first dorsal vertebrae on the right (fig. 6).

Spinal puncture revealed an almost complete block in the spinal canal.

Operation.—On June 25, a cervical laminectomy was done, and the spine of the seventh cervical vertebra was found to be movable. Tumor material extruded between the laminae, and on removal of the laminae, the tumor was seen to extend from the sixth cervical to the second dorsal vertebra, lying entirely extra-

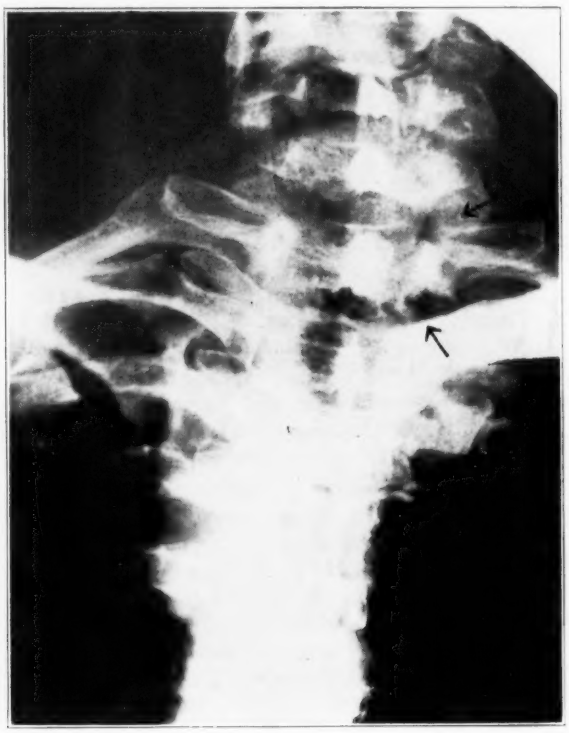

Fig. 6 (case 8).—Anteroposterior roentgenogram of the spine, showing the enlarged intervertebral foramen between the seventh cervical and first dorsal vertebrae on the right (upper arrow), and erosion of the body and lamina of the first dorsal vertebra on the right (lower arrow).

durally. Laterally, the tumor dipped down on the right side of the cord, extending anteriorly, and passed through the intervertebral foramen between the seventh cervical and first dorsal vertebrae and the first and second dorsal vertebrae. It was white and rubbery in texture and was not particularly vascular. The tumor was removed piecemeal with the seventh cervical root on the right side, without opening the dura. The tumor at the foraminal exits was coagulated with a Bovie unit. Microscopic examination showed a dural endothelioma.

Course.—The patient was discharged from the hospital two weeks after operation. At this time spinal puncture showed no block, and sensation was much

improved, though there had been no appreciable motor change in that short interval. The patient was seen in April, 1932, when he had no complaints except of residual weakness of the right hand, which had improved very little. The left arm and the legs were normal. Roentgen examination showed no change in the tumor in the chest reported previously.

CASE 9.—*Numbness of the lower extremities for a year, followed by weakness of the legs. Partial removal of an extradural tumor; recovery.*

History.—Mrs. J. H., aged 34, one year before entry to the hospital on Oct. 14, 1930, had noticed pains between the scapulae and occasionally a sharp twinge down into the legs. After two months this pain subsided, but paresthesia and numbness of the legs appeared, advancing to the nipple line in eight months. Beginning in May, 1930, she had increasing difficulty in walking, which had been especially marked during the last two months; about the same time she lost control of the sphincters. Also there were occasional tingling sensations in the fingers of both hands.

Examination.—Horner's syndrome was present on the left. There were no palpable masses in the neck. The gait was unsteady, with the feet wide apart and the toes dragging on both sides; the left leg showed more weakness than the right. All forms of sensation were absent below the fifth dorsal segment. The lower reflexes were hyperactive, more evidently so on the left than on the right, with abnormal plantar and absent abdominal reflexes. Vasomotor changes were present, with flushing and sweating above the sensory level.

Spinal puncture demonstrated a complete block; the fluid showed slight xanthochromia and increased protein and globulin. Roentgen examinations of the cervical and dorsal spine gave negative results.

Operation.—On October 23, a cervicodorsal laminectomy revealed an extradural tumor on the left and anterolateral aspects of the cord, extending from the seventh cervical to the second dorsal vertebra. The mass was firm, blue and vascular and adhered tightly to the dura. As the underlying dura was excised and the tumor was removed laterally, it could be seen to extend through the intervertebral foramen between the sixth and seventh cervical vertebrae and the seventh cervical and first dorsal vertebrae on the left side. Because of the extensive anterior prolongation, a complete removal could not be accomplished, and the defective dura was left open. Microscopic examination showed dural endothelioma.

Course.—The patient's condition improved rapidly, and on discharge from the hospital, on November 13, she was able to walk well. When seen in March, 1932, she was apparently in normal health. No masses were felt in the neck, and roentgen examination revealed no demonstrable tumor in the chest.

CASE 10.—*Signs of compression of the cord for eight months. Partial removal of an intraspinal tumor; slight improvement.*

History.—Miss A. M., aged 22, one year before entry to the hospital on July 9, 1925, first noticed sharp lancinating pains over the spine in the middorsal region. These were aggravated by undue exertion, but at no time did they radiate anteriorly. About four months after the onset of pain she noticed numbness and tingling in a girdle distribution about the lower part of the abdomen, which gradually spread downward, involving both legs. Weakness of the lower extremities followed rapidly, and within six months there was almost complete spastic paralysis of both legs with loss of sphincter control.

Examination.—The patient had a spastic paraplegia, with increased reflexes in the lower extremities, associated Babinski reflexes and ankle clonus. The

abdominal reflexes were absent; those of the upper extremities were normal. No objective findings of note were recorded on general physical examination aside from a mild symmetrical enlargement of the thyroid gland.

Spinal puncture indicated an almost complete block, with increased protein and globulin, but a clear fluid. An injection of iodized oil was made into the lumbar region; none of the liquid could be made to travel above the seventh dorsal vertebra.

Operation.—On July 15, a dorsal laminectomy revealed a dark red, meaty tumor covering the dura beneath the fifth, sixth and seventh dorsal laminae. The tumor filled a large portion of the canal and was seen to extrude between the laminae of the sixth and seventh vertebrae at the time of their removal. The

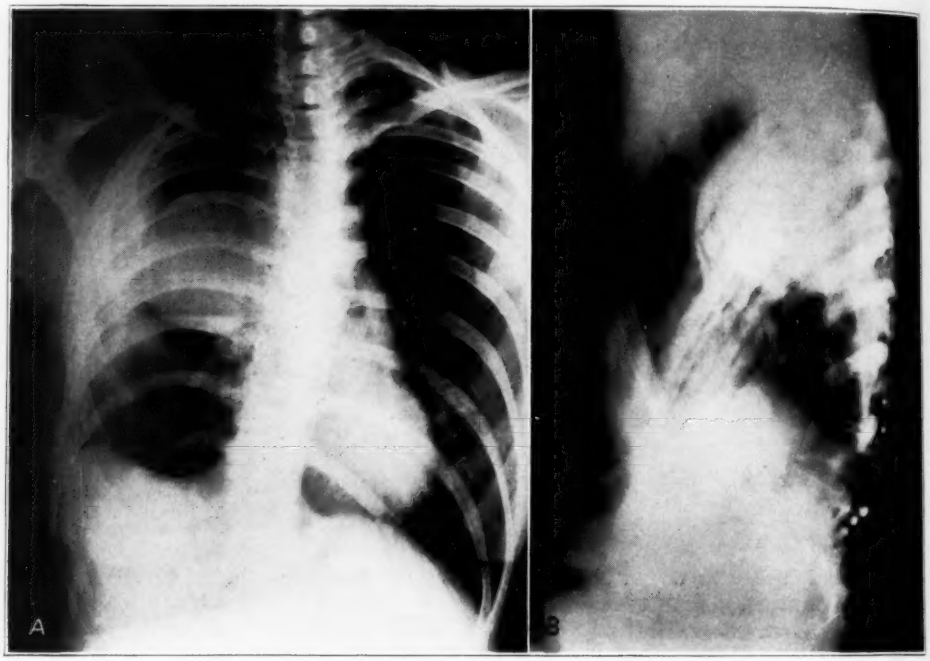

Fig. 7 (case 10).—*A*, anteroposterior roentgenogram, showing a large tumor of the chest which was connected through an intervertebral foramen with an intravertebral tumor at the same level. *B*, lateral view of the tumor seen in *A*.

tumor was extremely vascular and bled freely whenever it was touched. The operation was terminated because of the patient's condition. A second stage was done on July 31, when a tumor, 3 by 6 cm., was removed. It was apparent that complete removal could not be accomplished, and a wide decompression was done. The pathologist reported a hemangio-endothelioma.

Course.—The patient's pain was materially lessened, but there was little sensory or motor change.

Second Admission.—On Sept. 27, 1926, the patient reentered the hospital and reported that she had had no improvement for five months following the operation, but then began to notice increasing movement in the toes and ankles and

some slight improvement in sensation. She felt that there had been no change for the better since June, 1926, and that possibly some of the gain had been lost. Two weeks before this entry the patient had noticed soreness in the midthoracic region, somewhat to the right of the spine.

Reexamination.—There were marked dulness and absence of breath sounds in the right side of the chest posteriorly, over an area about 8 cm. in diameter. Neurologic examination revealed little different from the findings on the former entry, and paraplegia and sensory loss were again almost complete. Roentgen examinations of the thoracic region showed a shadow of considerable density extending out from the right hilus, and another less dense shadow extending into the posterior mediastinum. The mass could be demonstrated also just lateral to the vertebra, lying at the level of the operative defect (fig. 7).

Further Course.—Roentgen therapy was instituted over a prolonged period and was directed over the dorsal spine and adjacent thorax. Improvement followed, and about a year and a half later the patient was able to walk with help. Sensation improved markedly, and bladder and rectal control was fairly good. January, 1931, marked the peak of improvement, and then a return of symptoms began. Examination in August, 1931, showed signs of the mass in the right side of the chest posteriorly, and the paraplegia and sensory disturbances again were marked. Roentgen examination at this time revealed a tumor in the chest, and residual iodized oil in the spinal canal would not flow higher than the seventh dorsal vertebra. Further intensive roentgen therapy was given, with only slight improvement, and at the present time the patient has a paraplegia comparable to that present six years previously.

CASE 11.—*Increasing weakness and numbness of the legs for eight months. Removal of an extradural tumor; recovery.*

History.—Mrs. L. B., aged 33, eight months before entry to the hospital on April 20, 1931, noticed some difficulty in control of the legs, and two months later she was unable to dance. Paresthesias were present in the legs and extended to the hips, with more involvement on the left side than on the right. Three months after the onset, numbness began to creep up the legs, and she complained of a beltlike tightness about the umbilicus. In the last few weeks prior to admission, the progress of the symptoms was rapid, with the appearance of urgency of urination, inability to walk more than a few steps and involuntary jerkings of the legs.

Examination.—There were marked weakness of both legs, some spasticity, increased but equal deep reflexes, positive Babinski reflexes, ankle clonus and an absence of abdominal reflexes. A definite sensory decrease existed below the level of the fourth dorsal segment, and there was tenderness to pressure over the third dorsal spine.

Roentgen examination of the dorsal spine gave negative results. Spinal puncture showed a partial block, with clear fluid.

Operation.—On April 24, a dorsal laminectomy was done, revealing an extradural tumor beneath the third and fourth dorsal laminae. It was firm and fibrous and was attached to the dura. Laterally, on the right side, the tumor passed out through the intervertebral foramen between the third and fourth dorsal vertebrae. The intravertebral portion was removed as completely as possible, and the dura was left open at the point of excision. Microscopic examination showed a hemangio-endothelioma.

Course.—Continued improvement resulted; by June 11 the patient was walking fairly well, though a little unsteadily. Sensation was almost normal, and

motor power was good, though the reflexes on the right still were increased slightly. When seen in May, 1932, the patient was in excellent condition and had no disability.

CASE 12.—*A mass in the right lumbar region for two weeks. Signs of compression of the cord after entry to the hospital. Operation, without removal of the tumor; death.*

History.—L. Y., a girl, aged 2, entered the hospital on Sept. 11, 1926; two weeks before, the mother had noticed a mass, which had increased in size, in the right lumbar region, apparently without producing any symptoms.

Examination.—Nothing of consequence was noted in the general physical examination, except a mass, measuring about 5 by 4 cm., in the lumbar region to the right of the spine. On palpation it was hard, nonfluctuating and deep. The child voided urine on the slightest stimulation of the genitalia. The reflexes of the legs were somewhat hyperactive but equal; about ten days later the patellar reflexes were absent. There was some sensory disturbance in the legs, which was more marked in the right.

Roentgen examination revealed an area of increased density involving the third lumbar vertebra, but without destruction of bone. Spinal puncture showed an almost complete block, xanthochromia and an increase in protein and globulin.

Roentgen therapy was instituted, three treatments being given. The lower part of the legs showed a further decrease in movement. On October 6, the mass was punctured and aspirated. The pathologist reported a blood clot containing some malignant cells, possibly of sarcomatous origin. On November 3, a tumor was palpable in the left side of the abdomen, low down. Roentgen examination, eight days later, showed no change from the previous picture.

Operation.—On December 9, a laminectomy was done, and tumor tissue was found in the soft tissues on both sides of the spinous processes. On removal of the laminae, the tumor mass was seen overlying the dura. It was vascular and so extensive as to make complete removal impossible. A small portion was removed, and the wound was closed. Microscopic examination showed a fibrous hemangio-endothelioma.

Course.—The child became progressively worse after the operation and died two months later. Autopsy revealed a retroperitoneal endothelioma invading the vertebra, the spinal canal and the vena cava, with metastases to the lungs and liver. In spite of the metastatic character of the tumor, the involvement of the cord was from compression and was not secondary to the destruction of bone.

CASE 13.—*Weakness of the left leg for one month. Partial removal of an extradural tumor; no apparent improvement.*

History.—B. T., a girl, aged 3, entered the hospital on June 28, 1926, with a history of considerable loss of weight during the preceding month and a complaint of pain in the left knee and lower part of the back for two weeks. Prior to admission she had had no difficulty in walking, but there was limitation of motion of the back, although no particular point of tenderness was noted. Roentgen examinations of the back and knees gave negative results. A body cast was applied. On July 30, the patient was transferred to the neurosurgical service. She had continued to lose weight and had persistent pain in both knees, the left hip and the right leg. There had been weakness of the left leg for a week or ten days, followed shortly by similar, rapidly progressing changes on the right side.

Examination.—Movements of the lower extremities were extremely limited, but there were slight plantar flexion, a little movement in the hip and some

quadriceps movement on the right. There was spasticity of both lower extremities. Both sphincters were involved, and sensation was impaired bilaterally from the groins down, but the loss was much more marked on the left side. The reflexes in the upper extremities were normal; the abdominal, patellar and achilles reflexes were absent; there were no pathologic reflexes or clonus.

Spinal puncture yielded xanthochromic fluid, with evidence of incomplete block, and increased protein and globulin.

Operation.—On August 24, a large extradural tumor was exposed, extending from the eleventh dorsal to the second lumbar vertebra, with marked compression of the cord. No pulsation was apparent below the tumor. The tumor mass was dark blue and was vascular, making it impossible to remove any great portion of it. The pathologic report on this specimen was hemangio-endothelioma, with a tendency to self-limitation and fibrosis. There was relief from pain following this first-stage operation, but no appreciable change in the power or sensation of the legs.

On October 28, the second stage of the operation was done. At this time an increase in the growth was noted. It was of darker color, somewhat leathery in consistency and not so vascular as at the first operation. It was removed from the dorsal aspect of the dura, but extended anteriorly, particularly on the left side, and passed through an intervertebral foramen. Only a partial removal was accomplished at this operation, as the tumor extended well down anterior to the cord. Microscopic examination of this material showed a hemangio-endothelioma with more malignant characteristics than were present in the first specimens.

No improvement was noted after the operation. No further data are available, but it is probable that the patient succumbed early.

CASE 14.—*Pain in the chest for one week and paraplegia for two days. Portions of an intravertebral tumor removed on two occasions; death from the complications of a thoracic tumor.*

History.—R. S., a boy, aged 7, entered the Children's Hospital on Oct. 29, 1930, with the complaint of pain under the right shoulder followed by generalized pains in the chest during the preceding week. Questioning brought out that he had had occasional pain in the right side of the chest for three years, but never enough to cause any concern. Two days before admission there had been a rapid onset of paraplegia, with loss of sphincter control and anesthesia to the waist. There was nothing suggestive in the past history except for the transient pain in the chest, and the child apparently had been considered in good health.

Examination.—The child was rational and cooperative, but appeared sick. The temperature was 100 F.; a few cervical glands were palpable bilaterally, and the neck was moderately resistant. There was a definite bulge in the right side of the chest just below the scapula, and this area exhibited tenderness to pressure, decreased movement, marked dulness and distant breath sounds, but no râles. The paraplegia was complete and flaccid, with abolished reflexes and a sensory loss up to the eighth dorsal segment.

Spinal puncture produced only bloody fluid and strongly suggested a block, findings which were the same on subsequent punctures. Roentgen examination was reported as showing a destructive process involving the right transverse process of the sixth dorsal vertebra and a large paravertebral abscess from the fifth to the tenth rib on the right. The heart was displaced forward, and there appeared to be collapse of the lower lobe of the right lung caused by pressure and upward extension of the abscess. On November 3, paracentesis of the chest on the right side yielded only a slight amount of bloody fluid. Tuberculin tests,

blood cultures and a Wassermann test all gave negative results. The presence of a tumor was suspected in spite of the roentgen diagnosis of an inflammatory process.

Operation.—A dorsal laminectomy was done on November 5. Tumor material was encountered in the muscles of the back; this extended down to the lamina and, laterally on the right side, was seen to dive down into the thoracic cavity. The material was encapsulated, firm and yellow and had the formation of bunches of grapes. When the laminae were removed, extensive tumor material was seen extradurally, extending from the third to the seventh dorsal vertebra. This tissue, which extended down ventrally on either side of the cord, was reddish and friable, and was vascular in contrast to the extravertebral portions. As much of the tumor as possible was removed, and the block seemed to be relieved.

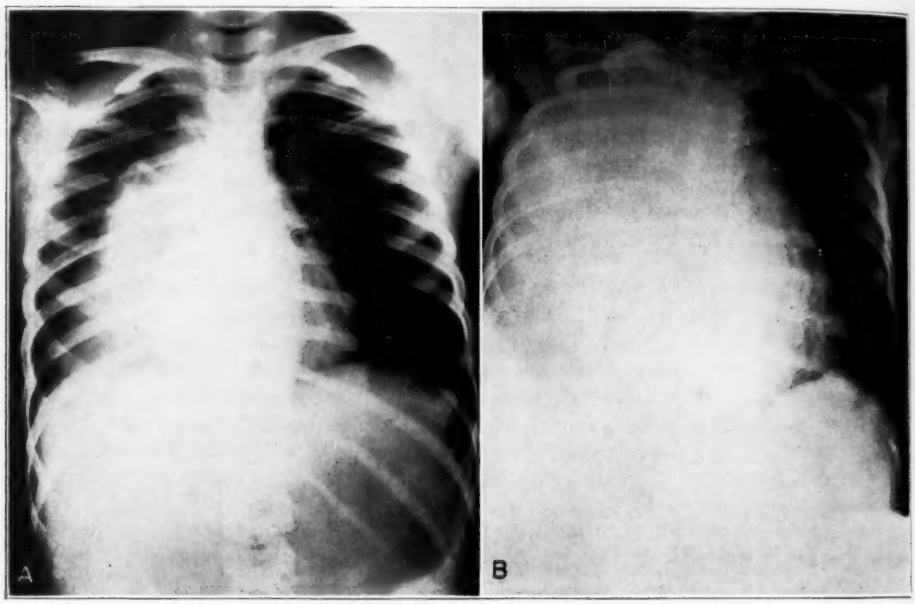

Fig. 8 (case 14).—*A*, roentgenogram showing a tumor mass in the right side of the chest associated with an extradural tumor which produced a paraplegia. *B*, same as *A*, taken at a later date, showing the great increase in the size of the tumor of the chest.

The patient's condition did not warrant further extravertebral exploration. There was considerable debate as to the pathologic diagnosis, but tentatively it was given as hemangio-endothelioma.

Course.—Only slight improvement followed the removal of the tumor, though one month later spinal puncture indicated only a partial block. Further roentgen studies, on December 9, suggested increasing changes in the right side of the chest, with a large pneumothorax and collapse of the lung, revealing multiple tumor masses in the pleura. There was an increasing kyphosis at the level of the sixth and seventh dorsal vertebrae, with increased destruction of the right sixth and seventh ribs. The heart and mediastinum were displaced to the left (fig. 8).

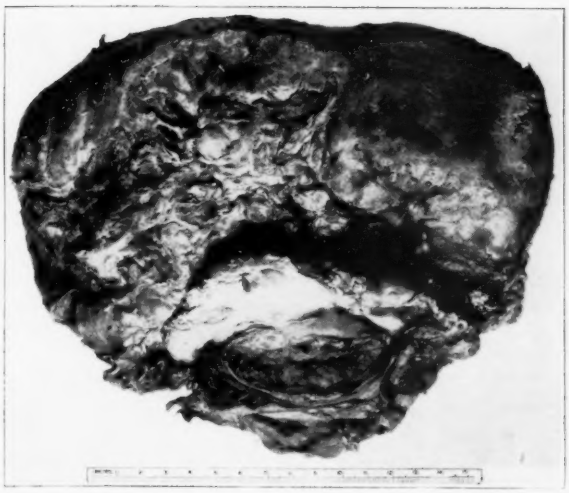

Fig. 9 (case 14).—Photograph of the tumor of the chest seen in figure 8. This tumor (a ganglioneuroma) was removed at autopsy; it filled the entire right side of the chest cavity and was connected with the extradural tumor through an intervertebral foramen.

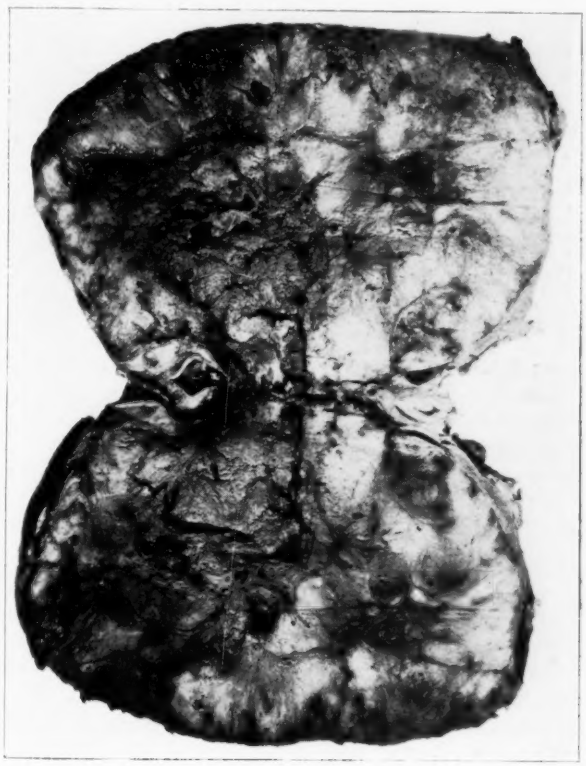

Fig. 10 (case 14).—Same as figure 9, shown in cut section.

A second tap of the chest procured about 1 ounce (30 cc.) of bloody fluid containing many large mononuclear cells, probably arising from a tumor.

Second Operation.—On December 30, when the former incision was reopened, it was apparent that the tumor about the cord had recurred extensively. The cord again was stripped of tumor material in an attempt to relieve the compression, but no appreciable improvement resulted.

Subsequent Course.—During the next three months the child gradually failed, with increasing pulmonary signs and constant fever; he died on March 26, 1931. Autopsy revealed a recurrence of the tumor about the cord and communication laterally through the intervertebral foramen with an enormous thoracic tumor, which filled almost the entire right side of the chest cavity. It was firm and

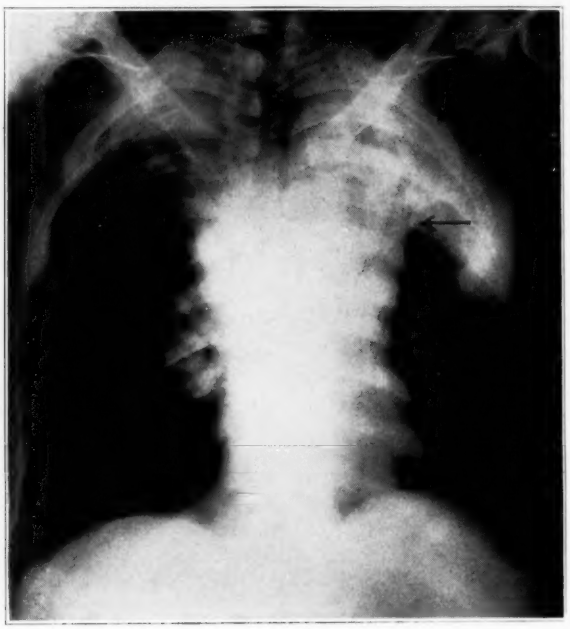

Fig. 11 (case 15).—Roentgenogram of the chest, showing the thoracic portion of an hour-glass tumor, indicated by the arrow.

nodular and apparently was encapsulated (figs. 9 and 10). A final pathologic diagnosis of all the material was ganglioneuroma of sympathetic origin.

CASE 15.—*Weakness of the arms and legs for ten years, with recent increase in symptoms. Partial removal of an extradural tumor; death from pneumonia.*

History.—Mr. A. G., aged 59, entered the hospital on Aug. 19, 1931, giving a history of weakness and numbness of the right arm and leg, with a rapid onset ten years before. The weakness soon involved the left side in less degree, but with a sensory loss greater than that on the right. There was transient urinary incontinence. Approximately a year and a half after the onset, all of the symptoms began to improve. This improvement continued until the patient was strong enough to do some work, but at no time did he have a complete recovery. The right leg showed the most residual symptoms, but the sensory decrease on the left remained annoying. There was little change until

November, 1930, when he noted increasing weakness of the lower extremities and, soon afterward, involvement of the arms with motor changes more marked on the right, but sensation chiefly affected on the left. He had considerable girdle-like pain about the thorax, which was aggravated by coughing or straining, and sphincter control had been lost.

Examination.—There was an almost complete flaccid paraplegia, with an absence of abdominal reflexes and reflexes of the lower limbs. There was marked weakness of both arms, especially noticeable in the muscles supplied by the eighth cervical and first dorsal segments; in these, considerable atrophy was apparent. The reflexes of the arm were increased on the right side; weakness was greatest on that side, and the right arm was spastic. The patient was incontinent. There was clinical evidence of a mass at the left apex of the chest, and roentgen examination showed a tumor in the superior mediastinum, extending more to the left than to the right. It filled most of the left apex and extended somewhat into the right apex (fig. 11). Its outline was not sharp at any point and was somewhat wedge-shaped in its anteroposterior diameter. There was a round shadow, 2 cm. in diameter, just above the right lateral costophrenic sulcus which looked like a metastatic malignant tumor. Posteriorly the third rib appeared moth-eaten. The cervical and dorsal spine showed no demonstrable change.

Spinal puncture revealed an almost complete block, with xanthochromic fluid and increased protein and globulin.

Operation.—A cervical laminectomy was done on Sept. 1, 1931. No changes of the bone were seen, and the laminae appeared normal throughout. A friable, pinkish-gray, extradural tumor mass covered the cord from the sixth cervical to the first dorsal vertebra. It was removed by blunt dissection without bleeding; it then was seen that the mass extended down on the right side of the cord and anteriorly so far as to make complete removal impossible. The tissue seemed to pass through the intervertebral foramen. Nothing was found intradurally, and jugular compression brought fluid down readily, indicating a relief of the block. Microscopically, the tumor was a carcinoma.

Course.—Some slight sensory improvement followed, but the patient died of pneumonia thirty-four days after the operation. Autopsy showed a carcinoma of the lung, with metastases to the glands of the mediastinum, the liver, the left third rib, the sixth and seventh cervical vertebrae, the first and second dorsal vertebrae and the intervertebral disks and entering the vertebral canal.

The damage to the cord resulted from strangulation by carcinomatous tissue in the canal and not from invasion of bone or subsequent pressure. It is for this reason that this malignant type is included in the series. It is worthy of emphasis that the first appearance of symptoms was ten years before admission to the hospital. The relation of the original lesion of the cord to the carcinoma of the lung may only be speculated on.

SUMMARY

Hour-glass tumors of the spine occur with far greater frequency than is indicated by the literature on the subject. They are so common that, in making a diagnosis of compression of the cord from tumor, the possibility of the tumor being of hour-glass type should be kept in mind.

In the neck, careful palpation may reveal an extravertebral mass. In the dorsal and lumbar regions, as well as in the cervical region,

diagnosis is aided by roentgenograms, which should include views of the intervertebral foramina and the interlaminal and interspinous spaces. Deformity of these is suggestive.

The majority of hour-glass tumors are encapsulated. In some instances complete removal of the intraspinal and extraspinal portions at one stage may be possible; in others second-stage operations for the removal of the extraspinal portions may be required.

Thoracic tumors have been removed, only to be followed by hydrothorax resulting from clear cerebrospinal fluid because the tumor was not recognized as being of the hour-glass variety and the dura was torn.

Fifteen cases are added to the sixty-eight reported previously.

CONCOMITANT DISSIMILAR DISEASES OF THE NERVOUS SYSTEM

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In reviewing the pathologic material of the nervous system in the laboratory of the Philadelphia General Hospital, we were impressed by the fact that two dissimilar conditions occurring in the nervous system at the same time were most unusual. The infrequency of combined lesions of the nervous system well fits in with the almost axiomatic rule that, if possible, the clinical diagnosis should include one disease only. In more than five thousand cases that have come to autopsy here in twelve years, less than ten have shown two or more basic conditions at the same time. Yet this question comes up frequently at the bedside. The problem of tumor in association with advanced vascular disease is not to be considered here, but forms a special chapter in itself.

Cases in which a combination of two or more basic conditions is present in the central nervous system are scattered infrequently through the literature, and the reports are usually limited to one case.

REVIEW OF THE LITERATURE

Several instances of tumors associated with syphilis have been noted (Moersch,[1] Martin,[2] Kant,[3] Obarrio, Orlando and their associates [4] and Pfanner [5]). These authors stressed the difficulty of a differential diagnosis, particularly since a choked disk may occur in both conditions.

From the Wards and Laboratory of Neuropathology of the Philadelphia General Hospital.

Read at the Fifty-Eighth Annual Meeting of the American Neurological Association, Atlantic City, N. J., June 7, 1932.

1. Moersch, F. P.: Brain Tumors and Syphilis, Am. J. M. Sc. **175**:12, 1928.

2. Martin, Paul: Tumors of the Brain and Syphilis, Arch. Surg. **18**: 1531 (April) 1929.

3. Kant, F.: Differential Diagnosis of Tumors and Syphilitic Disease: Clinical, Serological and Anatomic Study, Arch. Psychiat. **93**:343, 1931.

4. Obarrio, J. M.; Orlando, R., et al.: Tumor, Neurosyphilis and Epilepsy: A Case, Rev. argent. de neurol., psiquiat. y med. leg. **4**:328, 1930.

5. Pfanner, A.: Subependymal Glioma in Dementia Paralytica: A Case, Arch. gen. di neurol. e psichiat. **8**:5, 1927.

In the presence of positive serologic tests with little or no response to intensive treatment, they suggested a diagnosis of tumor and advised attempts at definite localization and extirpation.

Sedláčková [6] published a case presenting a hemibulbar syndrome due to syphilis, that was associated with a tumor at the base of the brain. Kirch-Hertel [7] described a case of tuberous sclerosis, associated with other maldevelopments and tumors of the brain; von Meduna [8] also reported a case of tuberous sclerosis and glioma in the same person. Fulton and Bailey [9] published a case of tumor of the third ventricle with Recklinghausen's disease, associated with Quincke's edema. Roger, Brémond and Siméon's [10] case was one of frontal neoplasm with a tumor of the right cerebellopontile angle. Other authors who described two or more tumors in the same patient are Sands [11] (frontal angioma and endothelioma), von Behrendsen [12] (cholesteatoma of the pia and glioma of the left hemisphere) and Barthels [13] (two cases of multiple primary sarcoma of the meninges with invasion of the brain, and multiple endothelioma and neurofibroma of the base); Stromeyer's [14] case was one of sarcoma of the base plus cholesteatoma. Marinesco and Draganesco [15] described a case of cholesteatomatous epidermoid cyst in the spinal cord associated with syringomyelia, while Roberti [16] reported a case of tumor of the frontal lobe associated with delirium tremens. Schlesinger's [17] case was one of tabes and syringo-

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6. Sedláčková, E.: Hemibulbar Syndrome: Syphilis; Tumor at Base of Brain, Časop. lék. česk. **66**:601, 1927.

7. Kirch-Hertel, Maria Pia: Tuberöse Hirnsklerose mit verschiedenen Missbildungen und Geschwülsten, Zentralbl. f. allg. Path. u. path. Anat. **33**:65, 1923.

8. von Meduna, L.: Tuberöse Sklerose und Gliom, Ztschr. f. d. ges. Neurol. u. Psychiat. **129**:679, 1930.

9. Fulton, J. F., and Bailey, P.: Tumor of Third Ventricle Associated with Recklinghausen's Disease and Quincke's Edema, Arch. argent. de neurol. **5**:1, 1930.

10. Roger, Brémond and Siméon: Associated Tumor of Frontal Lobe and Cerebello-Pontile Angle of Right Side: A Case, Rev. d'oto-neuro-opht. **7**:116, 1929.

11. Sands, I. J.: Multiple Primary Cerebral Neoplasms: Report of a Case, Arch. Neurol. & Psychiat. **16**:447 (Oct.) 1926.

12. von Behrendsen: Ein Fall von gleichseitigem Auftreten zweier verschiedenartiger Hirntumoren, Deutsche med. Wchnschr. **25**:710, 1899.

13. Barthels, J.: Multiple Primary Sarcoma of Meninges with Multiple Endothelioma of Base, Ztschr. f. Heilk. **7**:281, 1925.

14. Stromeyer, F. A. H.: Ueber ein mit Sarkom kombiniertes Cholesteatom des Gehirns, Beitr. z. path. Anat. u. z. allg. Path. **47**:392, 1909.

15. Marinesco, G., and Draganesco, S.: Cholesteatomatous Epidermoid Cyst in Spinal Cord, Co-Existing with a Syringomyelitic Process, Rev. neurol. **2**: 338, 1924.

16. Roberti, C. E.: Frontal Glioma in Case of Delirium Tremens, Rassegna di studi psichiat. **19**:466, 1930.

17. Schlesinger, H.: Die Syringomyelie, ed. 2, Vienna, Franz Deuticke, 1902, p. 33.

myelia. Spiller [18] also gave an excellent report of syringomyelia associated with tabes dorsalis. He further reviewed the literature up to the time which contained reports of other cases of a similar association. Oppenheim, in his textbook,[19] noted several instances of two tumors in the same patient—Klaufeld, glioma and endothelioma; Cornil and Rohin, a similar case, and other cases reported by Wohlwill and Josephy. He mentioned that there were a few cases on record in which mixed tumors had been found with a tubercle in the midst of a glioma. Davison, Schick and Goodhart [20] reported two case of cerebellar hemangioblastomas with incidental changes in the spinal cord.

REPORT OF CASES

Of less than ten cases in which this combination occurs, we have selected six in which two or more dissimilar processes were going on at the time of the death of the patient.

CASE 1.—*Thirteen years after loss of vision, admission to the hospital because of progressive weakness of the right side of the body; mental deterioration had begun six weeks before. Serologic tests positive. Generalized tremors and loss of reflexes. Pathologically, a metastatic tumor in the left frontal lobe, with all evidences of the tabetic form of dementia paralytica.*

Clinical Data.—N. L., a white man, aged 50, was admitted to the Philadelphia General Hospital, in the service of Dr. Edward Strecker, on March 21, 1930. He had begun to have dimness of vision in 1917, which had increased to complete blindness in 1922. Hearing had been diminished for several years. There had been a gradual development of general muscular incoordination for eight years. For about six months there was a loss of power in the right side of the body. There was considerable tremor of all the extremities, particularly of the right arm. This had existed for a few months. There was marked flexion at the right elbow and hip. There was a questionable Babinski sign on the right side. The tendon reflexes of the upper and lower extremities were absent bilaterally. He had complained of numbness of the feet and poor control of the bladder for several months. There was an absence of vibratory sensation and a marked diminution of position, localization and muscle and joint sensations. He had been unable to walk for nearly a year, but had been able to sit up in bed until a few days before admission. Both pupils were fixed. Hearing was greatly diminished. There was general muscular weakness on the right side of the body, with flexion. Mentally, he was restless and confused. At no time were there any convulsions.

Laboratory Examinations.—The urine was normal. There was a 4 plus Wassermann reaction with both blood and spinal fluid. The spinal fluid showed: 18 cells per cubic millimeter, 1 plus globulin and a gold curve of 3332211000; the pressure was 28 mm. of mercury.

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18. Spiller, W. G.: The Association of Syringomyelia with Tabes Dorsalis, J. M. Research **18**:149, 1908.

19. Oppenheim, H.: Lehrbuch der Nervenkrankheiten für Aerzte und Studierender, ed. 7, Berlin, S. Karger, 1923, p. 1385.

20. Davison, C.; Schick, W., and Goodhart, S. P.: Cerebellar Hemangioblastomas with Incidental Changes in the Spinal Cord, Arch. Neurol. & Psychiat. **25**:783 (April) 1931.

Course.—During ten days in the hospital, the patient showed increasing apathy and dulness. He failed rapidly and died on April 1, 1930.

Postmortem Examination.—There were chronic myocarditis, with terminal pneumonia of the right lung, interstitial changes in the kidneys, spleen and liver, and syphilitic aortitis.

Gross Examination of the Brain: A focal, well defined tumor was present within the anterior part of the left hemisphere. It measured about 6 cm. in diameter. It had occasioned a definite enlargement of that hemisphere and had caused obliteration of the ventricle, with deviation of the midline structures to the right.

The only other gross finding of importance was an unusual milkiness of the pia-arachnoid over the frontoparietal area bilaterally.

Microscopic Examination: The tumor proved to be a metastatic carcinoma.

Sections through the rest of the brain disclosed evidences of dementia paralytica. The findings, while typical, were early and were much more marked in the cornu ammonis than in the rest of the brain. Over the entire cortex, especially in the frontal region, there was well marked but not intense meningeal thickening as a result of fibrosis and edema, with an exudate in the subarachnoid space consisting mainly of lymphocytes and plasma cells. The cortex showed architectural disturbances as the result of loss of ganglion cells, glial increase, endarteritis, rod cells and perivascularly infiltrated vessels. In the basal ganglia the pathologic findings were extremely marked in the putamen and practically absent in the pallidum, while the islands of Reil were likewise severely affected. The spinal cord showed a picture typical of tabes dorsalis.

Comment.—In this case an active syphilitic process had been going on for many years. The patient had been treated for a progressive loss of vision and had been blind for more than thirteen years. The primary optic atrophy, in association with a complete absence of all reflexes and with pains in the legs, certainly suggested a tabetic process. The progressive weakness of the right side of the body with an equivocal Babinski sign was difficult to evaluate. The onset of mental symptoms and incontinence of the bladder a short time before death might have suggested a lesion of the frontal lobe, especially in association with a progressive hemiplegia. But in the presence of symptoms of syphilis and the serologic verification in both blood and spinal fluid, the clinician was unwilling to diagnose two lesions. While histologically the tumor was a typical metastatic carcinoma, even at autopsy the primary source of this tumor was not determined.

It should be emphasized that the histologic evidences of dementia paralytica were most marked in the cornu ammonis; this fits in with the work of Orton,[21] who showed that this region of the brain is usually first involved in this disease. The basal ganglia were more involved than the cortex. The presence of the tumor, which of itself might cause mental deterioration, makes it difficult to evaluate the mental picture, since either lesion could produce similar symptoms.

21. Orton, S. T.: Distribution of the Lesions in General Paralysis, Am. J. Insanity **70**:829, 1913-1914.

CASE 2.—*Gradual development of incoordination of the right side for one month, with headache and vomiting. Enucleation of the right eye twenty-four years before; blindness in the left eye one year later. On admission, cerebellar symptoms on the right side. Pathologically, a vascular tumor in the cerebellum, which suggested Lindau's disease, and in the rest of the central nervous system a definite meningovascular syphilis.*

History.—S. McK., a white woman, aged 51, was admitted to the Philadelphia General Hospital, in the service of Dr. T. H. Weisenburg, on July 14, 1927. She had been well until one month before admission, when she complained of constant bitemporal headache, which radiated to the occiput. With this there were occasional spells of vomiting and weakness, with incoordination of the right side of the body. She had been blind for twenty-four years. A condition had developed in the right eye, necessitating its removal at that time, and one year later she became blind in the left eye.

Examination.—The patient was well nourished, but confused. There was no speech defect. The tendon reflexes of the arms and legs were active, but about equal on the two sides. There was no Babinski sign on either side, and no ankle clonus. There was ataxia in the finger-to-nose and heel-to-knee tests, which was more marked on the right side. There was past pointing on the right side. She could not sit up or walk without support. There was hypotonia of the muscles of the right side. No sensory change was demonstrated.

The Wassermann reaction of the blood was negative. The spinal fluid showed a 4 plus Wassermann reaction, 30 cells per cubic millimeter, an increase of globulin and a gold curve of 1233221000. The urine was normal. The urea nitrogen of the blood was 15 mg.; the sugar, 87 mg.

Course.—The patient gradually grew duller mentally and weaker physically; she died suddenly on Sept. 14, 1927.

Necropsy.—Gross Examination of the Brain: There was a sharply demarcated, reddish, roughly spherical mass in the inner and most anterior part of the inferior surface of the right cerebellar hemisphere. It had produced a definite deformity of the brain stem and had pushed the pons and medulla toward the left. It was sharply demarcated and was easily removed from the cerebellar hemisphere; it left behind a cavity, the floor of which was ragged and irregular as the result of a pressure degeneration of the surrounding tissue. The mass measured approximately 3 cm. in diameter. On section, the tumor was extremely vascular. On cutting through the brain stem, the deviation of the structures toward the opposite side was easily discernible.

Microscopic Examination: Throughout the entire nervous system, but particularly at the base, the meninges showed marked fibrosis and the presence of a mild cellular exudate made up mainly of lymphocytes, with occasional plasma cells. While in places these cells were scattered diffusely throughout the subarachnoid space, there was a tendency for their collection in the perivascular spaces of some of the larger blood vessels.

The large blood vessels, especially at the base, showed marked intimal thickening, without degenerative changes, for the most part uniform around the entire wall of the blood vessel. The elastica was normal for the most part, but occasionally there was defibrillation. The adventitia showed marked proliferation and in its meshes were numerous lymphocytes and occasional plasma cells.

The medium-sized blood vessels occasionally showed typical changes of the Heubner type, with scanty adventitial infiltration.

The tumor was solid, without cyst formation, with a definite capsule of connective tissue, and was extremely vascular. The blood vessels for the most part were intensely dilated and filled with blood, their walls showing only a single layer of endothelial cells. Between the dilated vessels was a substance made up mainly of nuclei of endothelial type lying in a fairly dense matrix of connective tissue fibrils. A great deal of vacuolization was present. The tumor conformed in every way with the cerebellar angioblastoma described by Lindau,[22] and which has been reported in the literature under a variety of names, such as perithelioma, angioendothelioma, endothelial sarcoma and perithelial angiosarcoma.

The organs of the body showed no angiomatosis or other lesions. The retina of the eye that remained was not studied, because the condition was entirely unsuspected.

Comment.—The history of enucleation of an eye twenty-four years prior to death, with blindness in the other eye, and the finding post mortem of a cerebellar angioblastoma suggest a combination of von Hippel's[23] with Lindau's[22] disease (Rochat,[24] Collier[25] and Lindau, Sargent and Collins[26]), although no microscopic study of the eye was made. Clinically, a lesion of the right cerebellar hemisphere was diagnosed. The only important evidence of syphilis was a positive Wassermann reaction with the spinal fluid. Pathologically, the Heubner form of endarteritis and the meningeal infiltration with lymphocytes and plasma cells are proof of the syphilitic etiology.

CASE 3.—*Sudden onset of right hemiplegia with aphasia. Wassermann reaction of the blood 4 plus. Pathologically, a tuberculoma in the left capsular region and an endothelioma attached to the wing of the sphenoid.*

History.—E. A. F., a colored woman, aged 70, who was admitted to the Philadelphia General Hospital, in the service of Dr. Charles W. Burr, on Aug. 12, 1927, had been well up to two weeks previously, when there appeared suddenly a right hemiplegia with motor aphasia. At the onset there was unconsciousness for four hours; later she could say a few words, but most of her speech was unintelligible. She was a widow and had had one child who died at the age of 6 years.

Examination.—The patient was fairly well nourished. She had a right hemiplegia and nearly complete motor aphasia. The pupils were unequal and irregular, the right being the larger; they reacted sluggishly to light. There was weakness of the right lower part of the face. There was no marked change in the eyegrounds. The blood pressure was 180 systolic and 90 diastolic. The heart was moderately enlarged to the left; there were no murmurs. The tendon reflexes of

22. Lindau, A.: Cysts in the Cerebellum: Structure, Pathogenesis and Relation to Angiomatosis of Retina, Acta path. et microbiol. Scandinav., supp. 1, 1926, p. 1.

23. von Hippel, E.: Der anatomische Grundlage der von mir beschriebenen sehr seltenen Erkrankung der Netzhaut, Arch. f. Ophth. **79**:350, 1911.

24. Rochat, G. F.: Grosshirnangiom bei Lindauschen (von Hippelscher) Erkrankung, Klin. Monatsbl. f. Augenh. **86**:23, 1931.

25. Collier, W. T.: Lindau's Disease: Two Cases, Brit. M. J. **2**:134, 1931.

26. Lindau, A.; Sargent, P., and Collins, E. T.: Vascular Tumors of Brain and Cord, Proc. Roy. Soc. Med. (Sect. Neurol. and Sect. Ophth.) **24**:1, 1931.

the right arm and leg were exaggerated over those of the left; there were a Babinski sign and ankle clonus on the left. The right arm and leg were moderately spastic. Owing to the aphasia, tests for sensation were unreliable. Apparently pain and temperature were intact.

There were a trace of albumin in the urine, a 4 plus Wassermann reaction of the blood serum, blood sugar of 76 mg. and urea nitrogen of 10 mg.

Course.—At no time was there an abnormal rise of temperature. The patient failed gradually and died on Sept. 7, 1927.

Postmortem Examination.—There was passive congestion of the body organs, with chronic myocarditis, syphilitic changes in the aorta and sclerotic changes in the kidneys and spleen.

Gross Examination of the Nervous System: At the base of the skull was a roughly spherical, encapsulated, well demarcated mass, 2.5 cm. in diameter, which remained attached to the crest of the lesser wing of the sphenoid bone, immediately to the right of the optic nerve and the anterior clinoid process.

In the region of the posterior half of the left basal ganglia, occupying the internal capsule in its posterior two-thirds and extending into the lenticular nucleus and the thalamus, was a mass, 3 by 2 cm. in size, which had compressed and eroded all the structures in its immediate neighborhood. It had the gross characteristics of a tuberculoma.

Microscopic Study: The mass attached to the lesser wing of the sphenoid was a typical fibroblastic tumor of the type described under the name of psammoma. The lesion in the interior of the brain was a typical tuberculoma, with an area of central necrosis surrounded by a collar of round cells, in the midst of which were many giant cells of the foreign body type with many endothelial nuclei.

No tuberculosis was demonstrated in the lungs, and no mention was made of it in the general pathologic study of any of the organs of the body. Unfortunately, the lymph glands of the mediastinum were not removed for microscopic study because the condition found in the brain was absolutely unsuspected. There was, in addition, a definitely syphilitic condition of the aorta, which was in keeping with the serologic findings in the blood. There was, however, no evidence of frank syphilitic invasion of the cerebral structures.

Comment.—In this case there was a tuberculoma deep in the subcortical tissue associated with a small endothelial tumor attached to the dura at the base of the brain. In view of the advanced age of the patient, a vascular lesion was suspected clinically, especially when a positive Wassermann reaction of the blood was obtained. No active tuberculosis of the body organs was disclosed; the lymph glands in various situations were not carefully studied. The meninges were free from tuberculous involvement.

It is possible to have small endothelial tumors in the location described in this case which at times compress the various cranial nerves in a peculiar fashion so as to give rise to bizarre clinical pictures. We have seen one such tumor in the interpeduncular space with a clinical picture superficially resembling multiple sclerosis. In the case here reported the clinical picture is fully explained by the focal tuberculoma, the endothelial tumor not having caused any clinical symptoms.

CASE 4.—*Weakness, especially in the left upper limb for six months, with general tremor and an unsteady gait; loss of sphincteric control and weakness of the left side of the face. History of a chancre; positive Wassermann reaction of the blood. Pathologically, both an endothelioma and a glioma in the right frontal lobe.*

History.—J. W., a white man, aged 56, who was admitted to the Philadelphia General Hospital, in the service of Dr. M. A. Burns, on Jan. 24, 1925, had been well until five months before, when there had developed gradually muscular weakness and tremor of the left hand and arm, with an unsteady gait. The left side of the face showed some motor weakness in its lower division. He grew restless and became confused, and later sphincteric control was lost. There was a gradual increase of all symptoms up to the time of admission. The patient had had a chancre in 1890, and severe rheumatic fever in 1918. The wife had had nine pregnancies with only two miscarriages.

Examination.—The patient was well nourished and markedly confused. There was considerable tremor of all extremities, especially of the left hand and arm. There was muscular weakness of the left arm and the left side of the face. There was ataxia of the left hand. The pupils were sluggish to light but reacted better in accommodation. The eyegrounds were normal. Apparently there was no disturbance of sensation; the tests, however, were not reliable because of the mental confusion. There was no Babinski sign or ankle clonus on either side; the reflexes were more active on the left.

Laboratory Examinations.—There was a 4 plus Wassermann reaction of the blood. The blood sugar was 70 mg.; the urea nitrogen, 14 mg., and the uric acid, 3 mg. The urine was normal.

Course.—The patient received antisyphilitic treatment, and for a while there was some improvement in strength. He then grew rapidly worse and died of pneumonia on May 20, 1925.

Necropsy.—Gross examination of the brain: There were a definite enlargement of the right hemisphere as compared with the left and a shifting of structures over the median line toward the left, with invagination of part of the right hemisphere into the left under the falx. At the tip of the right frontal lobe was a fairly well encapsulated tumor, which had all the gross characteristics of an endothelial lesion. On horizontal section, it was found that the enlargement of the right hemisphere was not due to the small endothelial lesion situated at the tip of the right frontal pole, but that there was a tremendous enlargement of the entire right hemisphere anteriorly as the result of an intracerebral neoplasm. This not only involved all of the right frontal lobe, but extended into the corpus callosum and over into the subcortical tissue of the left hemisphere. As the result of tissue proliferation there was deviation of the structures toward the left to such a degree that the right ventricle was practically occluded on the left side, and there was almost complete obliteration of the left ventricle anteriorly. By no stretch of the imagination could it be supposed that a tissue proliferation of such marked degree, with enlargement of the entire hemisphere, could have been produced by irritation from the anteriorly lying tumor.

Microscopic Examination: The encapsulated tumor at the tip of the right frontal lobe showed the typical whorl-like arrangement of the so-called dural endothelioma or meningioma, but which is better called meningeal fibroblastoma. Sections from the cortex and subcortex directly behind the endothelial lesion showed all the characteristics of a glioma of the fibrillary astrocytic type. The same type of structure was present throughout the entire anterior part of the right hemisphere,

in the subcortical tissue of the left hemisphere adjacent to the corpus callosum and in the corpus callosum itself. There was such a gradual transition from this type of tissue to the normal brain structure that it was difficult to point out the place at which the transition occurred.

The question as to whether this tremendous overgrowth of fibroblastic glia was not merely the result of an irritative condition produced by the endothelial lesion at the frontal tip can be answered by stating that it is not usual for endothelial lesions to produce irritative hyperplasias to any great degree, such as occurs in gliomas, in which, even in parts distant from the tumor, a macroglial proliferation occurs. This is readily understood when it is realized that only rarely does an endothelial tumor produce a great increase of intracranial pressure such as is characteristic of a gliomatous tumor; with an increase of intracranial pressure, the arterial circulation is correspondingly hindered, and a relative anoxemia of the structures of the brain occurs, with ischemic changes in the brain and secondary gliosis.

Comment.—Multiple dissimilar tumors of the central nervous system are extremely rare, but the occurrence of two tumors, structurally different and adjacent to each other, is remarkable. The endothelioma occupied the frontal tip, while the glioma, which was of the fibrillar type, occupied the entire frontal lobe directly posterior and also invaded the motor area. Clinically, frontal lobe signs were present, as shown by confusion, tremor, loss of sphincteric control and unsteadiness in gait. The question of the mechanism of the production of these signs has been studied recently by Hare,[27] who concluded that the cerebellar signs are usually the result of implication of the corticopontocerebellar system.

CASE 5.—*Evidences of a recent left hemiplegia and some residuals of an old one on the right. Thickened vessels. A 4 plus Wassermann reaction with both blood and spinal fluid. Blood pressure, 130 systolic and 65 distolic. Postmortem, cerebrospinal syphilis and arteriosclerosis.*

History.—E. M., a white woman, aged 65, was admitted to the Philadelphia General Hospital, in the service of Dr. Charles W. Burr, on Oct. 13, 1925, in coma. A brother, who gave the history, knew nothing of the onset. The patient had lived in a boat house for eleven years, and had lived a rather rough life She had been sexually promiscuous all her life. She had been married at 18; nothing was known of any children or of what had become of the husband.

Examination.—The patient was in coma. The pupils reacted sluggishly to light and in accommodation; they were of medium size and equal. The eyegrounds were normal. The patient had frequent choking spells. The left arm fell limply to the side when lifted. There was moderate spasticity of the left leg. There were evidences of a slight right hemiplegia, evidently of old standing. The mouth was drawn to the left. All the tendon reflexes in both upper and lower extremities were equally exaggerated. There was a bilateral Babinski sign. She swallowed with difficulty. She was rather emaciated and had many scars from old injuries. The pulse was rapid and feeble. The temperature was slightly subnormal. She did not take nourishment. At times respiration

27. Hare, C. C.: Frequency and Significance of Cerebellar Symptoms in Tumors of the Frontal Lobe, Bull. Neurol. Inst., New York **1**:532 (Nov.) 1931.

was stertorous and rapid. She could be aroused somewhat at times, but did not make any responses. The blood pressure was 130 systolic and 68 diastolic.

The Wassermann reaction of the blood and of the spinal fluid was 4 plus. The blood contained: urea nitrogen, 17 mg.; sugar, 130 mg., and uric acid, 4.2 mg.

Roentgen examination of the skull, made because of the scars about the head, revealed no fractures.

Course.—The patient gradually grew worse; she lost weight; motion of the left side of body did not return, and there was slight weakness of the right side. The tendon reflexes continued exaggerated. She died on Oct. 27, 1925.

Clinical Diagnosis.—The diagnosis was cerebrospinal syphilis and arteriosclerosis.

Necropsy.—Gross Examination: The brain was abnormally small and weighed 1,120 Gm. There was definite thickening of the membranes over the anterior half of the cerebrum, hiding to a great extent the atrophy that was present. The vessels at the base showed marked sclerosis, with numerous yellowish plaques throughout; they were more marked in the carotid than in the basilar group of vessels. There was a rather marked internal hydrocephalus, with areas of softening in the subcortex and the basal ganglia bilaterally, the largest being on the right side and measuring 1 by 2 cm. in diameter; it involved the lenticular nucleus. The largest area on the left was 1 by 0.5 cm. and involved only the external portion of the lenticular nucleus.

Microscopic Examination: There were evidence of fibrosis and infiltration of the pia-arachnoid. The infiltrating elements were mostly lymphocytes, with a few scattered plasma cells and occasional phagocytic elements. The cortex showed definite narrowing, with a loss of ganglionic elements. Lamination was maintained throughout. The areas of softening in the subcortex and the region of the basal ganglia showed the typical structure of accumulation of gitter cells and vascularization.

The blood vessels of the brain showed two definite and distinct types of changes: 1. The large blood vessels showed an intimal thickening, for the most part limited to one sector of the vessel wall, with degenerative manifestations present to such a degree that ordinarily the structure was no longer discernible (figure). The elastica showed defibrillation and at times was actually ruptured. The media was thinned out and fibrotic. The adventitia, as a rule, was greatly distended by the accumulation of cells of the lymphocytic and plasma cell types. 2. The second type of vascular change affected mostly the medium-sized blood vessels. There was fairly uniform thickening of the intima as the result of fibroblastic proliferation without degenerative changes. The elastica, as a rule, showed mild defibrillation, but usually no rupture. The media gave evidence of little or no change. The adventitia, however, showed a marked dilatation as the result of infiltration with lymphocytes and plasma cells. At times vessels of both types were in immediate juxtaposition, when the difference between the former, which represented a typical atherosclerotic change with the addition of perivascular infiltration, and the latter, or the Heubner type of endarteritis, stood out in vivid contrast. There were thus present two pathologic entities: (1) a typical atheroma and (2) meningovascular syphilis.

Comment.—The combination of cerebrospinal syphilis with atherosclerosis is not unusual, especially in patients past 60. As a rule, however, one finds changes in the vessels due to age, with meningeal infiltration as the predominating evidence of the syphilitic infection. In

this case, side by side, were changes in the vessels due to syphilis and to age, many times within the same microscopic field.

Under the microscope it is usually easy to distinguish vessels affected by syphilis from those due to the wear and tear of ordinary life. The former have the characteristic features of Heubner's endarteritis, which is distinguished by a uniform, nondegenerative intimal thickening around the entire wall of the vessel, with but little change in the elastica and media, while the adventitia is dilated and infiltrated with inflammatory cells of the lymphocytic and plasma types. The atherosclerotic

Atheromatous plaque plus lymphocytic infiltration of adventitia in case 5.

vessels, on the contrary, are characterized by intimal thickening that does not take in the entire circumference. They show degenerative manifestations of all sorts, including liquefaction, lipoid change and calcification. As a rule, the media is degenerated, thin and fibrotic, and the adventitia shows few or no inflammatory elements. From the clinical standpoint it is difficult to tell which one of the two etiologic factors was responsible for the hemiplegic condition. The age of the patient would lead us to conclude that the atheroma was at fault. In younger persons, even when both processes are present, the syphilitic lesion is usually the more important.

CASE 6.—*Intermittent headaches for five years. On admission, headache, with vomiting, mental confusion and violence for about one week. Xanthochromic spinal fluid, with an increase of cells, all lymphocytes, and a negative Wassermann reaction. Post mortem, cystic tumor of the pineal gland and tuberculous meningitis.*

History.—W. H., a white man, aged 39, was admitted to the Philadelphia General Hospital, in the service of Dr. William Drayton, on July 29, 1926, complaining of headache and nausea which had existed for several months. There was pain in the neck, and the headache kept increasing; it had been followed by vomiting for three weeks. Speech had become irrational, and he had been restless for the past few days. The birth of the patient had been instrumental, but he had a normal childhood, never having had any serious illnesses, operations or injuries. The headaches had existed off and on since 1921, and had been associated each time with pain in the neck. He had been able, however, to continue work. He had never been examined carefully before admission to the hospital, but had been in a sanatorium for about a week before entering the hospital. Because of irrational talk and because he suddenly became violent in the sanatorium, he was transferred to the psychopathic department of the Philadelphia General Hospital.

Examination.—The patient was violent, disoriented and confused. After he had been calmed with sedatives, tremor of the fingers, frequent vomiting and slight weakness of the left side of the face were noted, with limitation of external rotation of the left eye. There was deafness in the left ear. The pupils were equal in size, were round and reacted promptly to light and in accommodation. An examination of the eyegrounds could not be made. The neck was rigid, and there was a positive Kernig sign. The tendon reflexes of the upper and lower extremities were diminished bilaterally; later they became absent at the ankles. There was no paralysis of any of the limbs, and no Babinski sign. Sensory tests were not reliable at any time because of the mental state.

Laboratory Tests.—Lumbar puncture revealed a straw-colored fluid, under pressure, which showed a heavy trace of globulin, 610 lymphocytes and a negative Wassermann reaction. A white blood cell count gave 11,300 cells, of which 78 per cent were polymorphonuclear. The Wassermann reaction of the blood was negative.

Course.—The patient was in the hospital only four days, during which he failed rapidly. He died on Aug. 3, 1926. A diagnosis of some form of meningitis was made before death, but the studies had not been completed.

Postmortem Examination.—A cystic tumor of the pineal gland and tuberculous meningitis were found. The tumor had been suspected, but the rapid course in the hospital, plus the mental state, hindered a complete study and a full diagnosis.

Gross Examination: The brain weighed 1,560 Gm. The body had been embalmed prior to removal of the brain, and the intense pallor was accounted for on this basis. There was little or no atrophy, but on the contrary the brain showed evidences of considerable tension, with flattening of the convolutions and little fluid in the subarachnoid space. The vessels at the base were bluish, collapsed and showed no evidence of sclerosis. On frontal section, a generalized ventricular dilatation was made out, but was not excessive. Overlying the superior colliculus was a tumor, nearly 2 cm. in diameter, in the situation occupied by the pineal body. There was mild compression of the superior colliculus, and the aqueduct was definitely narrowed at this point. The pineal body contained a considerable amount of fluid and collapsed on section.

Microscopic Examination: There was severe dilatation of the subarachnoid spaces due in part to edema and in part to an invasion by cells, mainly of the small lymphocytic type, with a tendency to greater concentration around the blood vessels and at times penetration into the superficial cortical layers. Here and there were small nodules with central necrosis, surrounded by cells of the same type plus an endothelial type of cell. The blood vessels for the most part were within normal limits, and the inner coats were not invaded by the inflammatory exudate. Some of the smaller vessels showed the typical invasion of the subintimal space by the inflammatory exudate. The cortex showed no architectural disturbances, but the ganglion cells showed a mild chromatolysis. Edema was a feature throughout. The ventricles, as a rule, were not involved by the inflammatory process.

The lesion of the pineal body seemed to be made up of groups of large oval nuclei with little chromatin and with definite but not sharply demarcated cytoplasm. The cells were arranged in definite islands, surrounded by a stroma of connective tissue. At first glance one would be tempted to make a diagnosis of an endothelial lesion, but in view of the histologic studies of pineal glands at different ages by Globus and Silbert [28] one could recognize this as the structure of the pineal body in early childhood. There was an absence of the characteristic small cellular elements that one usually sees around the mosaic arrangement of the large type of cell. In view of the fact that the tumor was cystic, but little tissue was obtained for study. It is possible that, as in case 5, reported by Globus and Silbert, other portions of the tumor might have had the usual two types of cell structures.

Comment.—That there was a tuberculous meningitis as the terminal event is clearly indicated by the clinical history and pathologic findings. This is not sufficient, however, to explain the presence of intermittent headaches for five years. Unfortunately, the mental condition of the patient was so bad that a detailed study was impossible and no aid was obtained from examinations of the eyegrounds and eye movements. There were no endocrine abnormalities.

The pineal body was enlarged to about twice its usual size, but because of the cystic condition only the wall could be studied histologically. This had the structure not of the infantile but of the adult type of gland. That regressive changes occur in the pineal body is well known, and cyst formation is fairly frequent, although calcium deposition is better known.

GENERAL COMMENT

From the clinical standpoint, a diagnosis of two or more pathologic processes or diseases in the central nervous system is difficult and often impossible. One should remember that multiple diseases may occur, and in cases in which the symptoms are not in accord with known pathologic lesions one should keep in mind that an accessory factor might be present to account for them. Syphilis is by far the most

28. Globus, J. H., and Silbert, S.: Pinealomas, Arch. Neurol. & Psychiat. **25**:937 (May) 1931.

common and important complicating factor; it may occur in association with any other pathologic process. A positive Wassermann reaction with either the blood or the spinal fluid or both may throw little light on the basic etiologic factor. Only too often have we had occasion, in cases of a tumor of the brain with a positive Wassermann reaction, to see operative treatment delayed until too late in an effort to give the patient the benefit of the so-called therapeutic test. A gross lesion of the brain, no matter whether neoplastic or granulomatous, requires surgical treatment, and the longer it is delayed the greater the destruction. While a positive Wassermann reaction can at times be obtained in a neoplastic patient without syphilis, this is by no means the rule. Martin [2] expressed the belief that the spinal fluid in cases suggestive of tumor of the brain should be heated to 56 C. in order to eliminate the possibility of a false positive result. At times an apparent temporary improvement can be obtained even in a case of tumor by the use of antisyphilitic remedies. A positive Wassermann reaction does not render a patient immune to any other condition. When a routine serologic study is made, more and more positive Wassermann reactions will be uncovered in every field of medicine.

The clinical diagnosis of two dissimilar processes has been made on several occasions. Schlesinger [17] and Spiller [18] have both diagnosed the occurrence of tabes and syringomyelia by painstaking clinical studies. It is true that in some of our cases additional pathologic findings have been made which give no clinical symptoms. These, of course, could not be diagnosed.

Pathologically, several points need to be stressed. First, the finding of a positive Wassermann reaction of the blood does not always mean that some abnormality of the central nervous system will be found. Second, many pathologic conditions can provoke so-called secondary inflammatory changes that have a striking resemblance to a syphilitic process; these must be carefully evaluated. We have omitted from this contribution a case in which meningeal carcinomatosis occurred in association with a mild round cell meningeal infiltration. This patient had positive blood and spinal fluid findings, but there were no characteristic changes in the blood vessels. In comparing this case with three others of meningeal carcinomatosis *without* positive serology, we found that in all there was a round cell meningeal infiltration in no way different from the case with positive syphilitic serology. It is well known that any irritative process can produce a secondary inflammatory reaction, not only in the meninges but in the brain substance itself, and it must be carefully evaluated. Around tumors, either primary or secondary, softenings, hemorrhage and other lesions a perivascular round cell infiltration is at times found. Whether or

not the cellular make-up consists of lymphocytes or gitter cells does not concern us here. It is possible that the latter is the true situation.

The possible pathologic combinations are great; aside from syphilis, tuberculosis and neoplasm may occur in association with any other process. We have described cases of carcinoma and dementia paralytica, Lindau's disease and syphilis, and endothelioma and tuberculoma in a patient with a positive serology; hence, neoplasms may occur in patients with syphilis and tuberculosis.

SUMMARY AND CONCLUSIONS

1. Multiple dissimilar lesions of the nervous system, while rare, occur frequently enough to compel consideration, especially when the symptomatology is not fully explained by one lesion.

2. Syphilis is the most common complicating lesion present.

3. The presence of serologic or clinical evidences of syphilis does not always mean that this is the only process present.

4. Surgical treatment should not be delayed too long in cases in which suggestive gross lesions do not respond quickly to antisyphilitic treatment, even though the serology is positive.

5. Multiple similar lesions are much more common, such as multiple tuberculomas, gliomas, abscesses, endotheliomas and vascular lesions.

MYELITIC AND MYELOPATHIC LESIONS (A CLINICOPATHOLOGIC STUDY)

II. TOXIC MYELOPATHY

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By far the largest number of cases of diffuse nonsystemic disease of the cord, excluding multiple sclerosis, are the so-called "myelopathies" or "myeloses." In these, the histopathologic changes, although essentially similar, may show some variations, largely owing to differences in the causative agents and the duration of the disease.

Myelopathic processes in diffuse nonsystemic disease of the cord, excluding multiple sclerosis, may be produced by (1) toxins or (2) circulatory interference. Toxins may produce myelopathy by affecting the ectodermal or the mesodermal elements of the cord, or both. Our cases belonged to the ectodermal group, and the pathologic process resembled that produced experimentally by introducing various toxins into the circulation or into the subarachnoid space. In the absence of other demonstrable etiologic factors we designate these cases as toxic myelopathies. When the mesodermal elements (blood vessels) alone are involved, the pathologic process is one of secondary softening due to circulatory interference; we could find no such cases in our material belonging to this group.

REPORT OF CASES

CASE 1.—*History.*—H. S., a man, aged 28, was admitted to the hospital in April, 1921, complaining of stiffness in the legs, inability to walk, loss of control of the bladder and rectum, and a sensation of tightness around the lower part of the chest. In December, 1920, the patient experienced a sensation of coldness in the left lower extremity and delayed thermal perception in both legs. A week later, the left knee became stiff, and urinary incontinence developed. The patient was admitted to another institution, where the case was diagnosed as multiple sclerosis; he was given typhoid vaccine, after which he improved somewhat and regained sphincteric control. He remained in this condition until admission to the Montefiore Hospital.

Examination.—Examination showed: right pupil larger than the left; narrower right palpebral fissure; bilateral ptosis; nystagmoid movements; left corneal

From the Neuropathological Laboratory, Montefiore Hospital.

Read at the Fifty-Eighth Annual Meeting of the American Neurological Association, Atlantic City, N. J., June 7, 1932.

hypesthesia; deviation of the uvula to the left; atrophy of the interossei and thenar muscles, which was greater on the right; lively jaw jerk; complete paraplegia of the upper motor neuron type; ataxic tremor of both hands, which was more marked on the right; loss of all forms of sensibility below the second dorsal segment, and bed sores over the sacrum, thighs and heels.

Laboratory Data.—The spinal fluid came out under markedly increased pressure and showed a 3 plus reaction for globulin and 70 cells per cubic millimeter. The Wassermann reaction was negative for the blood and for the spinal fluid.

Clinical Course and Diagnosis.—Flexion contracture of the right forearm and hand developed. Later, the movements of the right side of the diaphragm became impaired. The peroneal and calf muscles became atrophied, and the sensory level ascended to the fourth cervical dermatome. During the patient's stay in the hospital, there was a febrile course, varying from 101 to 104 F. He died on Oct. 19, 1921. A clinical diagnosis of infectious myelitis was made.

Necropsy.—Gross Examination: There were no gross abnormalities in the brain.

In the spinal cord, there were two very large areas of softening, one below the cervical and the other immediately above the lumbar enlargement; there were also several smaller areas of softening scattered between the two. On section, the anterior horns in the cervical region appeared enlarged, dark red and soft. There was some yellow mottling in the posterior columns and in the posterolateral margin of the cord, immediately ventral to the exits of the posterior nerve roots. The thoracic portion of the cord was thin and distorted, only a shell of gray matter being left.

Microscopic Examination: Myelin sheath sections from various levels of the pons and medulla oblongata showed nothing abnormal. With the hematoxylin-eosin stain, the perivascular spaces of the vessels near the restiform body showed edema with an accumulation of compound granular corpuscles; a similar type of cell was also found in the vessels of other regions. The meninges and the anterior spinal artery of the medulla oblongata showed in the perivascular spaces an accumulation of compound granular corpuscles.

Transverse sections of the cervical portion of the spinal cord showed with the myelin sheath stain slight cavitations of the gray matter, demyelinization of all tracts, except some fibers of the columns of Burdach, the anterior pyramidal tracts and the ventrocerebellar pathways (fig. 1 *A*). In the hematoxylin-eosin preparations a striking feature was the edema in the perivascular spaces, with the accumulation of compound granular corpuscles (fig. 1 *B*). Some of the vessels were surrounded by several layers of cells of the compound granular corpuscle variety (fig. 1 *C*). This was the preponderating histologic picture throughout the seventh and eighth cervical and upper dorsal segments. It is noteworthy that in spite of the extensive involvement of the cord proper, its meninges were neither markedly thickened nor infiltrated by compound granular corpuscles or lymphocytes. Thickening of the adventitia and, to a lesser extent, of the media was seen in the anterior and posterior spinal arteries. The anterior horn cells were in various stages of degeneration. The cavitations in the cervical region of the cord, though suggestive of so-called syringomyelia, were neither lined by ependymal cells nor surrounded by a glia wall (fig. 1 *A*). Longitudinal sections in the degenerated areas, especially in the posterior columns, showed with the myelin sheath stain massive disintegration of the myelin (fig. 2). With the Bielschowsky stain there was complete disintegration of the axis cylinders, some of which had a "corkscrew" appearance and ball-like terminations (fig. 3 *A*). In the region of the crossed pyramidal tracts the axis cylinders near the infiltrated vessels were tortuous but not

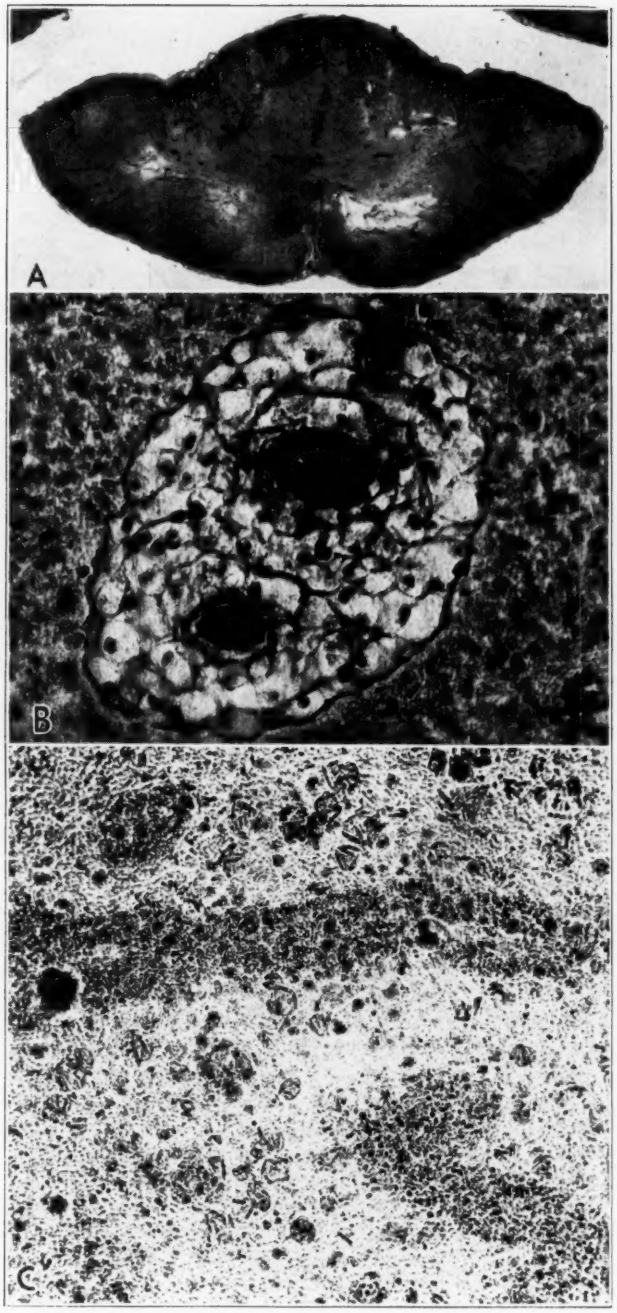

Fig. 1.—*A*, transverse section in the cervical region showing cavitations of the gray matter and complete demyelinization of all fiber tracts except for some fibers at the periphery. *B*, edema of the perivascular spaces filled with compound granular corpuscles. Hematoxylin-eosin stain; × 240. *C*, blood vessels surrounded by several layers of compound granular corpuscles. Fett Ponceau stain; × 50.

fragmented. With the Mallory phosphotungstic and victoria blue stains, the glia showed various stages of reaction. In areas in which the destruction was marked and in the field covered with compound granular corpuscles there was no glial response at all. In some areas in which the products of disintegration had been partially removed, the glial response was very much like that seen in subacute combined degeneration (pernicious anemia), that is, a poor glial response with a definite honeycombed appearance (fig. 3 *B*). In the crossed pyramidal tracts the glial response had the isomorphous appearance observed in ascending and descending

Fig. 2.—Longitudinal section showing marked disintegration of the myelin sheaths. Myelin sheath stain (Weil modification); × 480.

degenerations; this was especially noticeable in the cervical segments of the cord where the degenerative process was not marked. The dorsal and lumbar regions of the cord showed a picture similar to that in the cervical region, except that the pathologic process was less severe.

The diagnosis on microscopic examination was toxic myelopathy.

Comment.—The presence of large numbers of compound granular corpuscles so widely distributed throughout the cerebrospinal axis points strongly to a myelopathic process. The fact that these cells were brought

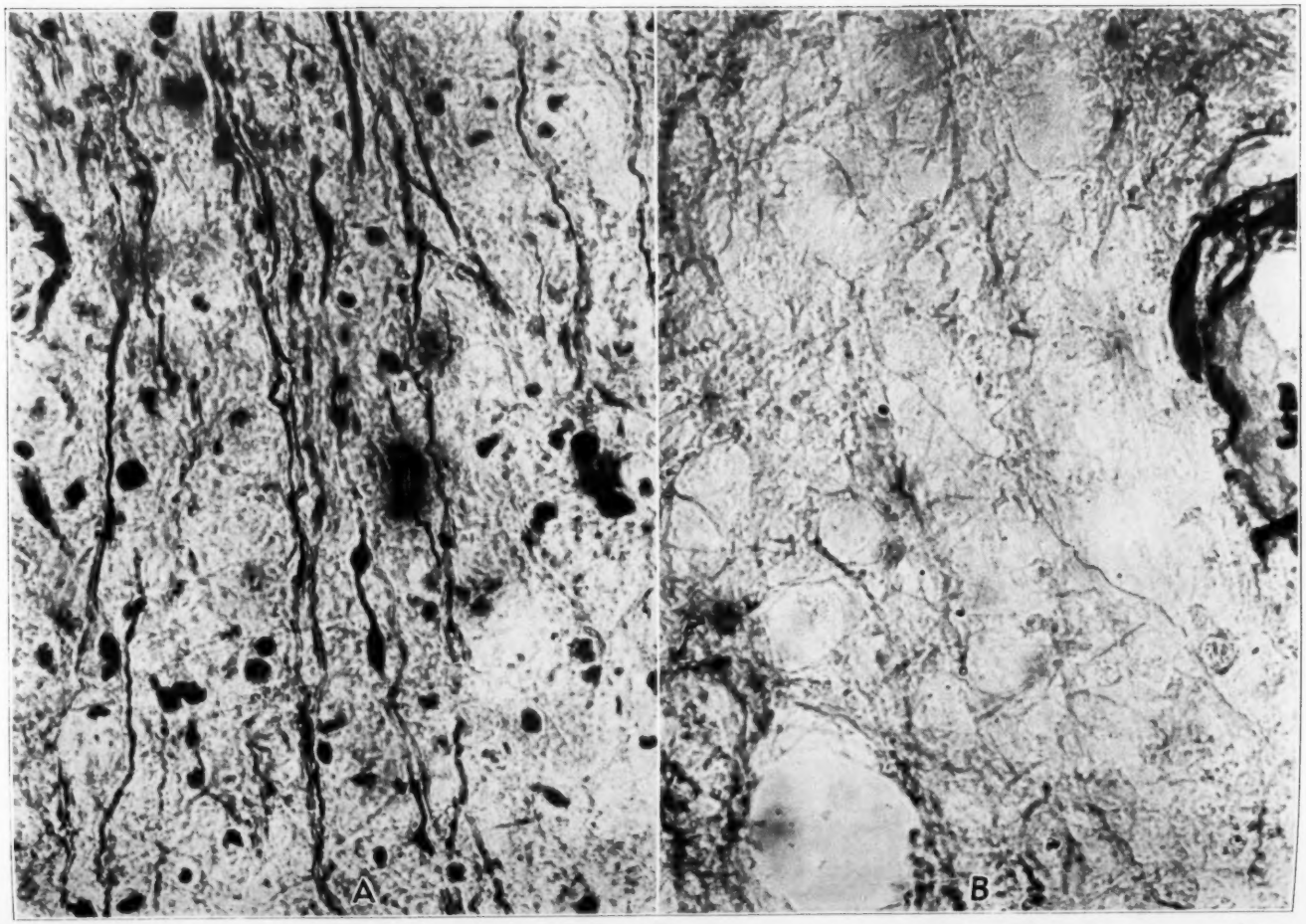

Fig. 3.—*A*, longitudinal section showing destruction, tortuosity and ball-like terminations of the axis cylinders. Bielschowsky stain; × 480. *B*, longitudinal section showing poor glial response. Victoria blue stain; × 480.

out so clearly by the Fett Ponceau method, although the material had been preserved in alcohol for so long a time, is additional proof of the degenerative nature of the lesion. As further evidence of the degenerative nature of the process we wish to emphasize the complete absence of lymphocytes, plasma cells and endothelial cells.

This case probably belongs to the group of cases of primary encephalomyelopathy thought to be due to an endogenous toxic process as described by Jakob, Hassin and others. The preservation of the axis cylinders in the crossed pyramidal tract in the presence of such marked pathologic changes in the same portion of the cord would on superficial examination place this case in the group of multiple sclerosis. The extensive localized destruction involving chiefly the cervical portion of the cord, the type of the degenerative reaction and the absence of increase in glia fibers usually observed in multiple sclerosis, however, exclude it definitely from this group. Pleocytosis in the spinal fluid, as observed in this case, has been previously reported in cases of softening and in other noninflammatory conditions of the cerebrospinal axis, and is of no diagnostic significance.

Case 2.—*History.*—A. F., a woman, aged 44, was admitted to the hospital on Feb. 28, 1928, with the history that seven weeks before admission a sensation of coldness in the lower extremities and weakness of both hands were experienced. Three weeks later, the legs gave way, and she fell. Two weeks before admission she was unable to walk and became bedridden. Except for a stillbirth at full term one year after her marriage, the past history was of no significance.

Neurologic Examination.—The pupils were irregular and unequal and reacted sluggishly to light; there was a vertical nystagmus. There was marked diminution of voluntary power in both lower extremities. The reflexes in the upper extremities were normal; the abdominal reflexes were absent; the knee and ankle jerks were more active on the left, with a positive Babinski sign and ankle clonus on the same side. There were hypalgesia from the toes to the twelfth dorsal segment on the right, analgesia on the left from the toes to the third lumbar segment and hypalgesia from the third lumbar to the twelfth dorsal segments. Disturbances of temperature were more marked than those of pain, whereas tactile sensibility was less affected. There was no impairment of the vibratory sense or of the sensibility of the joints.

Laboratory Data.—The spinal fluid came out under increased pressure and contained increased albumin and globulin and 8 lymphocytes per cubic millimeter. The Wassermann reaction was negative for the blood and for the spinal fluid. Cisternal puncture followed by the injection of iodized poppy seed oil 40 per cent showed no arrest of the oil.

Clinical Course and Diagnosis.—On May 21, the upper limit of the sensory level ascended to about the fourth dorsal segment, and some atrophy of the thenar and hypothenar eminences of both hands developed. Three weeks later, the patient also presented evidences of involvement of the anterior horns of the cervical cord and of the bulbar nuclei. Owing to the pupillary changes, the possibility of cerebrospinal syphilis was entertained, and she was subjected to vigorous antisyphilitic treatment, without improvement. She died on June 12.

The clinical diagnosis was disseminated meningomyelitis, possibly syphilitic.

Fig. 3.—*A*, longitudinal section showing destruction, tortuosity and ball-like terminations of the axis cylinders. Bielschowsky stain; × 480. *B*, longitudinal section showing poor glial response. Victoria blue stain; × 480.

Necropsy.—Gross Examination: The brain was not removed.

Only a small section of the cord, from the sixth cervical to the sixth dorsal segments, was available for anatomic study; it showed no gross abnormalities.

Microscopic Examination: With the myelin sheath stain, transverse sections of the cord showed demyelinization of almost all of the fiber tracts, the periphery being more involved than the center (fig. 4). The lesions were more marked on the left side of the cord. With the sudan IV stain, both the gray and the white matter were seen to be packed with compound granular corpuscles, some of which clustered around the blood vessels. The anterior horn cells showed marked pigmentation and poor Nissl substance, and some were atrophic. The vessels showed mild endarteritic changes. The meninges were slightly thickened and contained proliferated arachnoidal cells. The same was true of the anterior spinal artery, which showed a perivascular infiltration of glia cells. Longitudinal sections stained with the myelin sheath method showed fragmentation and disintegration of the

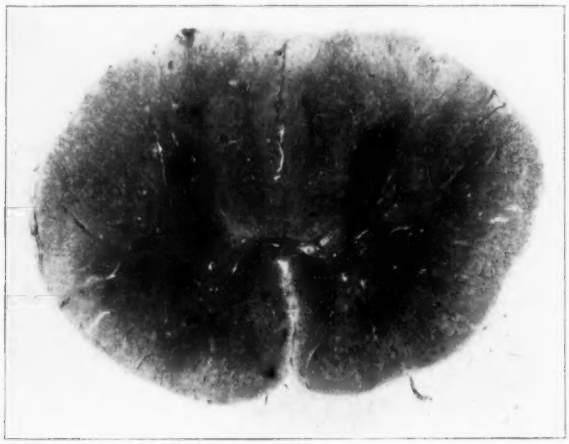

Fig. 4.—Transverse section of the cervical cord showing demyelinization of all the fiber tracts, the periphery being more involved. Myelin sheath stain (Weil modification).

myelin sheaths. With the Bielschowsky stain, the axis cylinders appeared fragmented; occasionally a swollen axis cylinder was seen. In the Mallory phosphotungstic and victoria blue stained sections there was a poor glial response. Toward the periphery of the cord there was beginning glial response with a tendency toward a honeycombed appearance. The microscopic diagnosis was toxic myelopathy.

Comment.—The short duration and clinical picture of the disease as well as the histopathologic observations point to a toxic process as the etiologic factor in the case. The absence of evidences of inflammation, the involvement of the periphery of the cord more than its center, the poor glial response, as well as the total absence of inflammatory perivascular reactive phenomena, would seem to indicate an affection of the cord by some toxic agent circulating in the cerebrospinal fluid and coming in direct contact with the periphery of the cord.

At the onset of the disease the symptoms pointed to a lesion at the level of the twelfth thoracic segment which, as the disease progressed, gradually ascended to the fourth thoracic segment, and finally involved the anterior horn cells and the bulbar nuclei. This is emphasized because in the toxic myelopathies the pathologic process is generally a disseminated one, not unlike that observed in the encephalomyelitides.

CASE 3.—*History.*—In E. B., a woman, aged 24, pulmonary tuberculosis developed in October, 1927, for which she was admitted to a sanatorium. She improved considerably and remained well until February, 1928, when fever developed and severe pain occurred in the lower part of the abdomen. One week later there appeared suddenly a flaccid quadriplegia, for which she was admitted to the Monmouth Memorial Hospital. Here she is said to have shown early bilateral papilledema, facial diplegia, nasal speech, paresis of the soft palate, complete flaccid quadriplegia, absence of deep reflexes, normal plantar responses, a level of hyperalgesia between the sixth dorsal and the eighth dorsal segments, and incontinence of urine.

Diagnosis and Course.—The case was diagnosed as one of "radiculomyelitis." All laboratory tests, including inoculations of the spinal fluid into guinea-pigs to determine the presence of tuberculosis, were negative. About one month after admission, the neurologic picture began to improve. The patient remained in this condition until Aug. 1, 1928, when she was admitted to the Montefiore Hospital with impaired vision, difficulty in swallowing and speaking, flaccid quadriplegia and loss of sphincteric control. She was markedly emaciated and showed evidences of pulmonary tuberculosis, with a pulse rate of 120. She died three hours after admission. A detailed neurologic examination could not be made. The clinical and anatomic diagnosis was quadriplegia of unknown etiology, chronic pulmonary tuberculosis, tuberculosis of the colon and tuberculous bronchopneumonia.

Necropsy.—Gross Examination: The brain and cord showed no abnormalities.

Microscopic Examination: With the myelin sheath stain of sections from the cervical and thoracic segments of the spinal cord there was observed demyelinization of the posterior columns, of the lateral and direct pyramidal and of the cerebellar tracts. The demyelinization was more marked at the periphery than in the center of these structures (fig. 5*A*). Under a higher magnification, the white matter had a honeycombed appearance. Some myelin sheaths were swollen; others were shrunken, while still others were completely destroyed. With the sudan IV stain the cord appeared to be one mass of compound granular corpuscles. The striking picture of these sections was the absence of fat-laden cells in the adventitial spaces of the smaller and larger vessels. The gray matter was free from compound granular corpuscles. With the hematoxylin-eosin and cresyl violet stains, the anterior horn cells showed no changes except that in some, especially on the left side, the Nissl substance stained poorly. Some of the cells appeared highly pigmented. Numerous monster glia cells were seen in the white matter, especially in the cervical region. A similar histologic picture was observed in every portion of the cord, but was more marked in the lumbar enlargement, where the posterolateral half was completely demyelinated (fig. 5*B*). There were no signs of an inflammatory reaction. The vessels appeared normal. The axis cylinders in longitudinal sections (Cajal and Bielschowsky) showed signs of degeneration (fragmentation and corkscrew appearance). Sections stained by the victoria blue and Mallory phosphotungstic methods showed a relatively poor glial response.

A microscopic diagnosis of toxic myelopathy was made.

Comment.—The histologic picture was that of an extensive degeneration of almost the entire cord. Our first impression was that tuberculosis might possibly have been the causative factor. In the absence of evidences of meningitis, tubercles or of any other inflammatory reaction, as well as the negative results of inoculations into guinea-pigs, this possibility was excluded. Owing to the coexistence of pulmonary tuberculosis, we are unable to state whether the fever at the onset of the disease was due to tuberculosis or to the disintegration of tissue such as may occur in tumors of the brain, hemorrhages, degenerations and

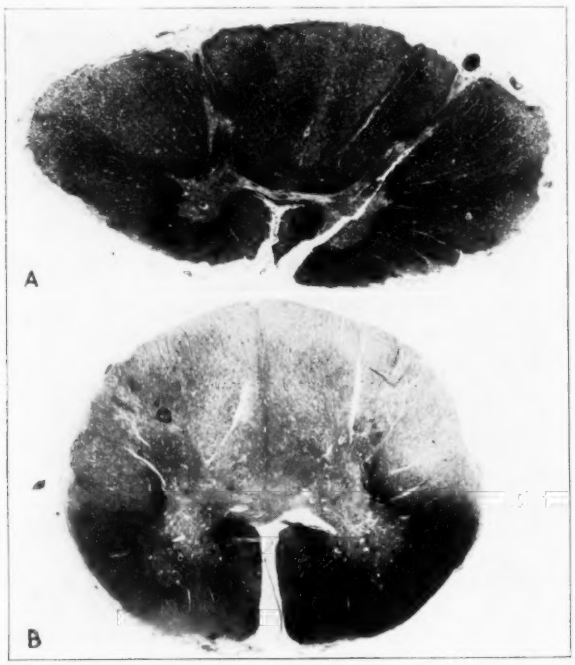

Fig. 5.—*A*, transverse section of the cervical cord showing demyelinization of the posterior columns, the lateral and anterior pyramidal tracts and the cerebellar pathways. The periphery of the cord appears more involved. *B*, section from the lumbar enlargement showing extensive demyelinization of the posterior and lateral columns. Myelin sheath stain (Weil modification).

softenings. In this connection, it should be emphasized that in cases of this type the presence of fever is not necessarily an indication that the pathologic process is inflammatory.

Case 4.—*History.*—D. G., a man, aged 52, was admitted to the hospital in October, 1928, complaining of weakness and numbness of the lower extremities, pain in the lumbar part of the spine, which radiated to the lower extremities, and loss of bladder and rectal control. In September, 1926, he experienced a continuous

dull pain in both knees and difficulty in walking. In July, 1928, he received twenty injections of neoarsphenamine. After the third injection, hiccup, fever, chills, paralysis and sensory disturbances of the lower extremities, pain in the lower part of the back, retention of urine, incontinence of feces and visual hallucinations developed.

Examination.—General examination gave negative results. The blood pressure was 124 systolic and 66 diastolic. Neurologic examination revealed: dysarthria, and vertical and horizontal nystagmus; the left lower extremity showed flexion and extension movements; right footdrop and weakness of the muscles of the lower extremities, more marked on the right. The deep reflexes were hyperactive in the upper extremities and present in the lower, except that the left patellar reflex could not be elicited. The left lower abdominal reflex was absent. There were a positive Mendel-Bechterew sign and Rossolimo's reflex on the right. There were hypesthesia, hypalgesia and hypthermesthesia from about the third lumbar to the first sacral segment. Cold was called "hot" below the fourth lumbar segment. Sense of position was impaired in the fingers and toes, and vibration was diminished in the lower extremities. Urinary and fecal incontinence were present. There were bed sores on the sacrum.

Laboratory Data.—There was a questionable subarachnoid block; no xanthochromia was noted. The Wassermann reaction was negative for the blood and for the spinal fluid. Roentgen examination of the spine disclosed advanced spondylitis.

Clinical Course and Diagnosis.—The clinical course was progressively downward and pointed to diffuse involvement of the central nervous system with the brunt of the lesion at about the twelfth dorsal segment. The patient died of urinary infection and terminal bronchopneumonia on April 2, 1931. A clinical diagnosis of myelitis was made.

Necropsy.—Gross Examination: The brain showed negative findings.

The spinal cord was thin in the middle and lower thoracic regions, and the crossed pyramidal tracts appeared translucent.

Microscopic Examination: Sections from the cerebral hemispheres, midbrain and medulla oblongata showed poorly stained ganglion cells and the falling out of some. In the cervical region of the spinal cord, the fasciculus gracilis, crossed pyramidal tracts, cerebellar pathways, part of the anterior pyramidal tracts and the lateral and ventral spinothalamic tracts were demyelinated. The periphery of the cord was more involved than the center (fig. 6). In some areas the periphery of the cord had a Swiss cheese appearance. Under a higher power magnification, the cord showed the destruction of some myelin sheaths and the occasional swelling of others. In the sections stained with hematoxylin-eosin and cresyl violet, the meninges and the blood vessels were normal. The ganglion cells of the gray matter were pyknotic; some were shrunken and had wavelike processes. Some of the chromatolysed ganglion cells also had collections of Nissl substance at the periphery of the nucleus and at the periphery of the cytoplasm. Within the degenerated areas there were numerous amyloid bodies and an increase in the astrocytes.

In the thoracic region, there were similar changes, except that the process of demyelinization was more marked. As in the cervical region, the fibers at the periphery were more involved than those near the center. The fasciculus cuneatus and the left direct pyramidal tract were also involved. Sections of the cauda equina appeared normal.

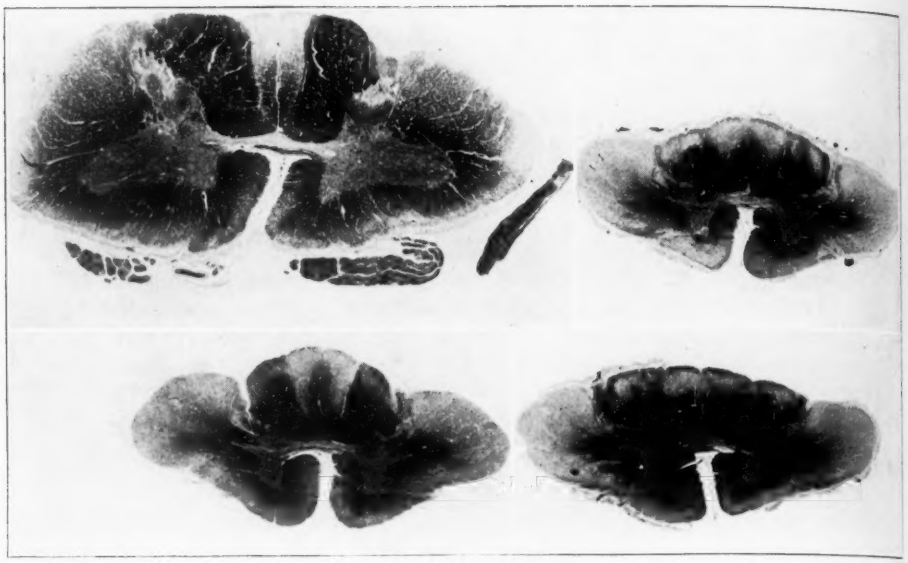

Fig. 6.—Transverse sections from the cervical region showing partial demyelinization of practically all the fiber tracts. The periphery of the cord is more involved. Myelin sheath stain (Weil modification).

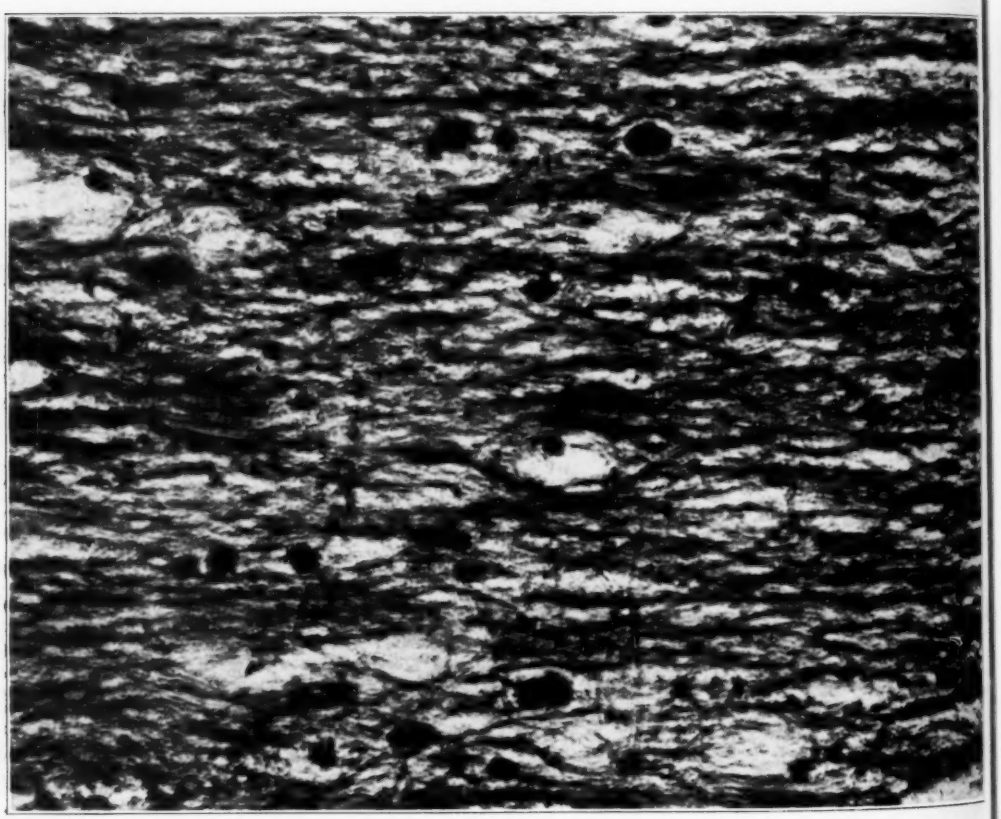

Fig. 7.—Longitudinal section showing dense glial proliferation in the demyelinated areas. Victoria blue stain; × 400.

Longitudinal sections through the posterior columns and crossed pyramidal tracts with the sudan IV stain showed the periphery to be almost completely replaced by compound granular corpuscles which were loaded with fat. In the myelin sheath sections there was intense destruction of the myelin sheaths; here and there swollen and fragmented myelin sheaths were also found. In the Bielschowsky preparations the axis cylinders were destroyed and had a granular appearance at the periphery. Fragmented, swollen and corkscrew axis cylinders were also observed. In the victoria blue sections the destroyed white matter was replaced by dense glial tissue (fig. 7) resembling that seen in multiple sclerosis, tabes dorsalis and similar conditions.

The diagnosis made on microscopic examination was toxic myelopathy.

Comment.—The clinical and histopathologic observations are in favor of the diagnosis of toxic myelopathy. There was a question at one time whether the process in the cord might not have been due to arsphenamine poisoning. The characteristic histopathologic features of arsphenamine poisoning are small focal degenerations, and not such fairly uniform marginal destruction as was found in this cord. The onset of the nervous symptoms and signs prior to the administration of arsphenamine would be further evidence that there was no causal relationship between the two. The intense glial proliferation in this case, as contrasted with the other toxic cases in our series, indicates a mild toxic agent which acted on the spinal cord for a period of four and one-half years. It may also be emphasized that the entire neuraxis was free from the usual histopathologic changes of syphilis or other infections. We are therefore inclined to attribute the pathologic process to some undetermined mild and slowly acting toxic agent.

GENERAL COMMENT

Four cases in our series were found to belong in this group. All presented a fairly uniform histologic picture: a honeycombed appearance of the white matter, destruction of the myelin sheaths, fragmentation of the axis cylinders and a poor glial response, except in one case (case 4) in which there was glial productivity.

In three cases (cases 2, 3 and 4) the peripheral zones of the cord were more affected than the center. Similar observations were recorded by Weil [1] and others, who studied experimentally the effects of toxins on the spinal cord. Weil,[1] by applying saponin to the spinal cord, produced a pathologic picture resembling that in our cases of toxic myelopathy. It would seem from these experiments that noxious agents (toxins) circulating in the cerebrospinal fluid first injure the most peripheral portions of the cord. If this is the case, it is readily conceivable that when such toxins remain in the subarachnoid space for a prolonged period they may also affect the deeper structures of the cord.

1. Weil, A.: The Effects of Hemolytic Toxins on Nervous Tissue, Arch. Path. **9**:828 (April) 1930.

So far as the blood vessels are concerned, it must be pointed out that there was no evidence of partial or complete obliteration of the vessels of the cord in any of the cases in this group. While it is true that in two of the cases (cases 1 and 2) the vessel walls showed some alterations, these were hardly sufficient to account for the pathologic process in the cord; the latter, therefore, cannot be attributed to circulatory interference from vascular occlusion.

The regressive glial changes found in these cases resembled those seen in subacute combined degeneration of the cord, in pernicious anemia—a process generally attributed to the effects of some hypothetic toxin. This is mentioned as further proof that the pathologic process in the cord in this group of cases was most likely due to toxins.

One of the cases (case 1) showed slight cavitation of the cord, which was neither lined by ependymal cells nor surrounded by glia, but by numerous compound granular corpuscles. The formation of this cavity was due to the removal of the products of disintegration from the areas of destruction in which there was no attempt at glial repair. Similar cavitations are occasionally found in degenerations, softenings, tumors and inflammations.

A review of the results obtained from experimentation with toxins on animals may be helpful in explaining the pathologic process in this form of myelopathy. Singer [2] injected oil paint into a vertebral artery and produced an embolus leading to softening in the cervical region of the cord. Hoche,[3] Rothman and Mosse [4] and Catola [5] injected toxins into the lumbar arteries through the abdominal aorta after ligating the renal and sphincteric arteries. The observations were not always constant. In some cases the injections were followed by softenings, in others by hemorrhages, and in still others by abscesses, especially in the gray matter. Lotmar [6] and Rosenthal [7] subjected a large number of rabbits to the action of varying doses of dysenteric toxin and guanidine, respectively; they found that large doses of these toxins produced a

2. Singer: Ueber experimentelle Embolien im Centralnervensystem, Ztschr. f. Heilk. **18**:105, 1897.

3. Hoche, A.: Experimentelle Beiträge zur Pathologie des Rückenmarkes, Arch. f. Psychiat. **32**:209, 1899.

4. Rothman, M., and Mosse, M.: Ueber Pyrodinvergiftung bei Hunden, Deutsche med. Wchnschr. **32**:134, 1906.

5. Catola, G.: A proposita di alcune mieliti innfetive sperimentali, Riv. di pat. nerv. **13**:241, 1908.

6. Lotmar, F.: Beiträge zur Histologie der acuten Myelitis und Encephalitis sowie verwandter Prozesse, in Nissl, F., and Alzheimer, A.: Histologie und Histopathologie: Arbeiten über die Grosshirnrinde, Jena, Gustav Fischer, 1913, vol. 6, p. 245.

7. Rosenthal, S.: Experimentelle Studien über die amoeboide Umwandlung der Neuroglia, in Nissl, F., and Alzheimer, A.: Histologie und Histopathologie: Arbeiten über die Grosshirnrinde, Jena, Gustav Fischer, 1913, vol. 6, p. 89.

regressive glial reaction in the cord, whereas smaller doses were followed by progressive glial changes, that is, glial productivity. These observations may be of some significance when compared with the glial response in our own cases of this group. In three of these (cases 1, 2 and 3) there was a regressive glial response resembling that following the action of large doses of toxic substances in animals; in the fourth case (case 4) there was glial productivity. Taking into consideration the duration of the disease in these cases in connection with the glial reaction in them, one is struck by the fact that in the cases with regressive glial changes the duration of the disease was much shorter than that in the case with glial productivity which lasted five years. It is conceivable that in the former cases the toxic agent was more virulent than in the latter.

A detailed study of the cords in these cases shows that the microscopic changes vary with the stage of the disease. In the early stages the axis cylinders are swollen and the myelin becomes disintegrated. As the process goes on to softening, the axis cylinders are almost completely destroyed, and their fragments surround the disintegrated myelin. Following this, the white matter assumes a honeycombed appearance. After the swelling and disintegration of the nerve fibers, the degenerated area is filled with compound granular corpuscles. If the process is arrested at this stage, the reactive glial phenomena come into play. The compound granular corpuscles become separated from the binding glia cells and migrate to the adventitial spaces, forming the so-called "perivascular cuffing"; at times this may have the appearance of an infiltration of round cells which must be differentiated from lymphocytes by special stains. With the clearing up of the products of disintegration there may occur proliferation of the glia cells and fibers similar to that observed in disseminated sclerosis and tabes. The ganglion cells in the anterior horns showed changes varying from scantiness to disappearance and complete destruction of the tigroid substance. The meninges showed occasional thickening of the pia-arachnoid due to the proliferation of the arachnoidal cells. It must also be emphasized that none of these cases showed the slightest evidence of an inflammatory process.

The clinical course was characterized by a rapid onset of symptoms of a level cord lesion, soon followed by evidences of multiple and diffuse lesions throughout the neuraxis, abnormal changes in cerebrospinal fluid and a short duration of the disease, except in one of the cases (case 4) in which it lasted four and one-half years. All cases terminated fatally. The clinical differentiation between toxic myelopathy, encephalomyelitis, so-called multiple sclerosis, myeloradiculitis, infectious myelitis and myelopathy due to circulatory interference from arteritis may be impossible.

SUMMARY

1. Four cases of toxic myelopathy in which the toxins affected essentially the ectodermal elements are reported.

2. The clinical picture was fairly uniform in all of them, and could not be distinguished from that of infectious myelitis.

3. The histopathologic picture consisted of marked destruction of the myelin sheaths and axis cylinders, poor glial response (except in case 4) and slight changes in the anterior horn cells. The blood vessels in the cord showed minimal changes, and the pathologic process could not be attributed to them. The process was diffuse throughout the neuraxis, but was most marked in the periphery of the cord. The histopathologic process showed no evidences of inflammation; therefore, the term "toxic myelopathy" is preferable.

Clinical Notes

AURICULAR NEURALGIA

GEORGE W. HALL, M.D., CHICAGO

One and a half centuries ago, Fothergill [1] spoke before the Medical Society of London on the subject of "A Painful Affection of the Face." Fothergill's paper described rather accurately the symptoms of trigeminal neuralgia. He stated that "to be able to distinguish and to cure with some degree of certainty, a disease that during the time it lasts is extremely excruciating, is an addition, however small, to the utility of our profession."

I have searched the literature with the hope that others more learned had reached concrete conclusions as to the factors behind the auricular neuralgias. In this I have been somewhat disappointed. The only clinical case that I can find which showed the same symptoms as those in the case I am about to report, both in character and limitation of involvement, is that reported by Harris,[2] in 1915, occurring in a man, aged 54, who for thirteen years had been subject to attacks of neuralgia in the right ear. The attacks could be induced by rubbing or washing the ear. The pain developed gradually for hours until a crisis was reached, and when the pain was at its peak the patient could not move until after the crisis was passed, when the pain gradually subsided. The ear became dead white while the pain lasted. Harris stated that the patient's only complaint was the sensitiveness of the ear; as rubbing it would start the neuralgia within an hour or two, he let the ear alone, never washing it or rubbing it if he could keep from doing so. Examination showed the ear to be normal except for accumulated dirt. There was no anesthesia, deafness or other abnormal physical sign. Harris further stated that the part most affected was the concha. He was inclined to regard the neuralgia as being of geniculate origin. A similar involvement of the ear has been reported in other forms of neuralgia, but such neuralgic attacks were never so limited in distribution. The glossopharyngeal neuralgias as reported by Doyle [3] included the auricle of the ear, but the attacks were brought on through the act of swallowing and included other symptoms involving the throat. Harris reported similar cases of neuralgia in which the spasm started in the region of the tonsil and spread to the ear and neck. The geniculate neuralgias would also come in this category, but they are not infrequently accompanied by herpes, and involve the canal of the ear, even the ear drum.

Hunt,[4] by employing the "approach system," or, as he put it, the "herpes zoster method," was able in his usual careful way to outline the cutaneous distribution

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Read at the Fifty-Eighth Annual Meeting of the American Neurological Association, Atlantic City, N. J., June 6, 1932.

1. Eiliott, John: Complete Collection of Medical and Philosophical Works of John Fothergill, London, J. Walker, 1871, p. 427.

2. Harris, Wilfred: Neuritis and Neuralgia, New York, Oxford University Press, 1926, p. 224.

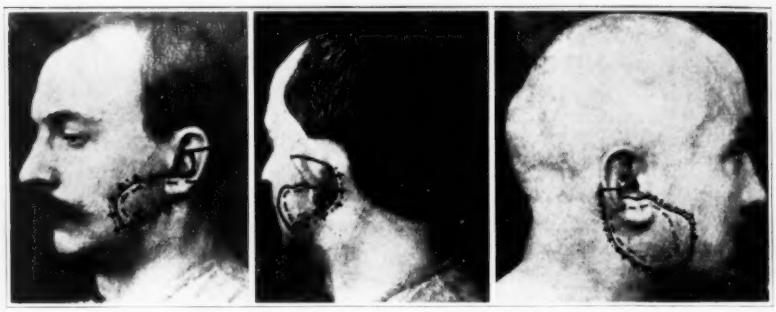
3. Doyle, J. B.: A Study of Four Cases of Glossopharyngeal Neuralgia, Arch. Neurol. & Psychiat. **9**:34 (Jan.) 1923.

4. Hunt, J. Ramsay: Brain **38**:418, 1915.

of the fibers from the geniculate ganglion to the ear. Most of his cases were associated with paralysis of the facial nerve. In his cases the herpetic eruption involved the canal of the ear, including the tympanum. Hypesthesia involving the concha was also present in some of the cases.

Clark and Taylor [5] demonstrated in rather a convincing way that the origin of "tic douloureux of the ear" in their case was in the pars intermedia of Wrisberg, as evidenced by postoperative results after this nerve was severed. After several years of observation, the auricular pain had not returned. In their case, however, the pain was deeply located in the canal, in the anterior wall of the external meatus and over a small area in front of the ear.

The auricle of the ear, however, derives its cutaneous nerve supply from so many sources that doubt is created as to whether neuralgia of the auricle may come from any one source. It derives its cutaneous supply from the sensory fibers of the seventh nerve through the geniculate ganglion, as stated, from the auriculotemporal branch of the trigeminal nerve and from branches from the ninth and tenth and also from the second and third cervical ganglia through the great auricular nerve.



Sensibility defect by interruption of the great auricular nerve (from Foerster [6]).

Such an interlacing and overlapping of cutaneous nerve supply gives room for speculation as to whether the pain may be derived from one source alone or from many sources.

It appears to me that each case must be studied individually, first, as to the exact location of the pain, secondly, as to whether it is localized or diffuse, and thirdly, as to the location of maximum intensity. From that point of view, I submit the following case history.

REPORT OF CASE

F. M., aged 60, first consulted me in August, 1926. The family history disclosed nothing of importance. The patient's gallbladder was removed in 1913. Arthritis involving the lumbar spine was discovered in April, 1924. There was no history of a syphilitic infection, and the Wassermann test of the blood was negative. The complaint at the time of examination was paroxysmal pain involving the left ear, of two years' standing. The pain was confined to the outer shell of the left ear, and was noticed especially over the lower part of the ear, involving to a less extent the lobe of the ear. The canal had never been involved, nor had there ever been any herpetic eruption. The attacks occurred at two or three week intervals, as a rule, during the colder months, and less often if the patient was in a warm

5. Clark and Taylor: J. Nerv. & Ment. Dis. **37**:242, 1910.

climate. He was able to tell when an attack was coming on because of the preceding "soreness," as he expressed it, on rubbing the ear, or on wriggling the ears (he has the ability of voluntarily moving the ears up and down).

The attacks come on gradually, in five or six hours reach the crisis, and gradually subside. During the attack the patient isolates himself, feels depressed and applies heat to the back of the neck, which he thinks shortens the attack. He never complains of headache, nausea or vomiting. The roentgenograms show a definite cervical arthritis with new formation of bone. About six years ago, he consulted an orthopedic surgeon, who applied traction of the head, hoping to relieve the pain by that method. The neuralgia, however, was constant and aggravated in the left ear while the traction was in place, but disappeared on its removal, after four days' trial. An interesting statement by the patient is that for several years he has always patronized the same barber, whom he cautions not to touch the ear, as he fears that it may produce pain. Between the attacks there have never been noted any subjective or objective sensory changes over the area involved. I have never seen any blanching of the ear during the few attacks I have personally observed. The ear, however, is so sensitive during the attack that the patient cannot have it touched without aggravation of the pain.

The illustration, taken from Foerster,[6] shows the cutaneous distribution of the great auricular nerve to the auricle of the ear.

SUMMARY

The limited area involved during the attacks of pain, corresponding to the cutaneous supply of the great auricular nerve, as well as the reactions experienced during and after the application of traction, inclines one toward the theory that the origin lies in the cervical region rather than in the geniculate ganglion. While herpes may occur in neuralgias of the cervical ganglia, it does not appear so constantly as in involvement of the geniculate ganglion.

In conclusion I shall take refuge behind the words of Fothergill, expressed in the eighteenth century: "The nature of this disease is rather submitted to your consideration as a matter of further inquiry than as an opinion sufficiently established." With these may be compared the words of J. Ramsay Hunt, who, after many dissertations on the ramifications of the sensory supply of the seventh nerve, stated: "My results are based very largely on the analysis and study by 'the Herpes Zoster Method.' They cannot be accepted as the final solution of this difficult problem. Many more observations will be required in order to determine more accurately the extent of these auricular and intra oral zones and their relationship."

ABSTRACT OF DISCUSSION

Dr. William G. Spiller, Philadelphia: The interest in Dr. Hall's presentation is due largely to the rarity of the condition and of the opportunity offered for studying the distribution of the auricularis magnus nerve. It must be remembered that any nerve distribution is not absolutely sharply defined, and that often it radiates beyond the recognized area. This is due partly to the fact that fibers overlap, and partly to individual idiosyncrasies.

In the innervation of the outer portion of the ear, one is dealing with a most complex mechanism. One has to take into consideration not only the trigeminal

6. Foerster, O.: Illustrations, in Lewandowsky, M. H.: Handbuch der Neurologie, Berlin, Julius Springer, 1929, p. 1410.

nerve, but the facial, the vagus and the pneumogastric nerves (it is almost impossible anatomically to separate the latter sharply from the vagus), and also the auricularis magnus nerve.

Dr. Hall has taken the best means to determine which nerve was affected in his case. It is unfortunate that he did not secure complete anesthesia from the injection of procaine hydrochloride followed by alcohol. If he had, he would have established satisfactorily that the auricularis magnus nerve was the cause of the neuralgia, and he would have the support of Foerster's observation after a destructive lesion of this nerve; but as the anesthesia was only partial, one cannot be sure that there was not overlapping of some of the nerves of the adjoining territory.

Dr. George W. Hall: Since this paper was submitted, the patient consented to "blocking" of the great auricular nerve with procaine hydrochloride. It was unfortunate, however, that this was not done during one of the attacks. As my associates and I had not obtained his consent to have the nerve "blocked" during the attacks, we were willing to attempt this procedure between the attacks with the hope of obtaining the effects of alcohol on the nerve. Consequently we injected 6 cc. of procaine hydrochloride (1 per cent) and obtained a definite and yet somewhat modified anesthesia over the area which is shown in the slides. Without withdrawing the needle we injected 2.5 cc. of 90 per cent alcohol, but as the anesthesia wore off within twenty-four hours, we concluded that either we did not strike the nerve with the alcohol or it was too diluted with the previous injection of procaine hydrochloride solution to produce permanent effects on the nerve. After the injection, the patient came to my office with the statement that he was not sure whether he preferred occasional attacks of neuralgia to having a persistent anesthesia of the ear. That is the position in which we are at the present time.

PNEUMORACHIOCLYSIS AND CERVICOLUMBAR IRRIGATION IN THE TREATMENT OF MENINGOCOCCIC MENINGITIS

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In the course of prolonged treatment of meningitis necessitating frequent lumbar punctures, the accumulation of exudate at the site of puncture may render treatment by the lumbar route particularly difficult. A local accumulation of fibrinous exudate with consequent productive changes in the meninges, sometimes resulting in loculation, not only prevents the removal of fluid but is frequently an obstacle to the injection of therapeutic serum. This eventuality may be due to the meningeal disease per se, to the irritant effect of serum, to trauma from repeated punctures or to all of these factors.

The cisterna magna offers an alternative route when the lumbar one is not suitable, either for the reasons mentioned or because of congenital malformation or deformity resulting from trauma. The cisternal route is of particular advantage in cases in which the maximum pathologic change is cerebral, because it permits the administration of serum nearer the point of infection and favors its more prompt dissemination through the cerebral subarachnoid spaces and ventricles. In some cases, at least, treatment through the cistern will prevent a fatality. When treating meningeal infections, therefore, one should always be prepared to do a cisternal puncture if and when the occasion demands.

Intrathecal injection of a small amount of air in the lumbar region followed by drainage and irrigation of the spinal subarachnoid space is an additional procedure that may prove of exceptional value. In its circulation through the subarachnoid space, the air may separate delicate pia-arachnoidal adhesions and thereby facilitate more complete drainage of the spinal fluid and promote the general distribution of injected serum. From a surgical point of view the rationale of irrigation of the subarachnoid space is indisputable. It clears the delicate leptomeninges of exudate and removes material that is laden with bacteria and their toxic products.

In order to accomplish this it is necessary to insert needles into the cisterna magna and the lumbar subarachnoid space. After removal of 20 cc. or more of spinal fluid from the cistern the head is elevated to about 45 degrees, and 10 cc. of air is injected through the lumbar needle. After a short interval the head is again lowered so that the axis of the spine is nearly horizontal and, by means of syringes or gravity tubes, saline solution is injected through the lumbar needle and removed from the cistern and vice versa.

I first utilized this method of treatment in a case of meningococcic meningitis in 1929. Before these measures were instituted the outlook seemed hopeless, but

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prompt improvement leading to complete recovery followed, and the conclusion seemed warranted that the favorable results should be ascribed to this method of therapy.

In 1931, Vibber and Tartakoff [1] recommended the injection of air in the lumbar region in conjunction with the administration of therapeutic serum, followed by alternate elevation of the head and feet, thereby promoting rapid dissemination of the serum. The method that I employed had the same object in view. It differed in that I combined cervicolumbar irrigation with the injection of air and permitted the escape of air at the cisternal level after it had circulated cephalad to that point. In my case the additional drainage of purulent fluid that followed was an advantage. It might have been desirable to inject more air in the lumbar region just before the procedure was terminated, but the immediate improvement would indicate that it was not necessary in this instance. Since 1929, the same method has been employed in other cases in which recovery has ensued, but in no instance has the value of these measures been so striking as in the first case in which it was used. For that reason some of the details of that case are cited.

REPORT OF CASE

On Jan. 16, 1929, an Italian boy, aged 14 years, was admitted to the medical service of Dr. C. F. Tenney, at the Fifth Avenue Hospital. The illness was initiated suddenly on Jan. 12, 1929, by headache, nausea, vomiting and pain in the back and extremities. During the first twenty-four hours, petechiae appeared in the skin of the back and abdomen.

Examination.—On admission the patient was acutely ill, and irrational at times; the temperature was 103 F., the pulse rate 120 and the respiratory rate 30. The pharyngeal pillars and posterior wall of the oropharynx were inflamed and covered with a mucopurulent exudate. The lungs were resonant throughout and normal except for a few scattered râles. The heart was normal in outline and irregular in rhythm; the rate was 120; the sounds were loud, and at the apex there was a systolic murmur. The abdominal viscera were normal. A moderate edema of the ankles was present.

Neurologic examination disclosed rigidity of the neck, with moderate opisthotonos, and irregularity of the pupils, the right being 1.5 mm. and the left 3.5 mm., with episcleral injection and cloudiness of the anterior chamber of the right eye. There was a positive Kernig sign on both sides; the reflexes of the upper extremities were present and of normal intensity; the same was true of the left lower extremity, but on the right side the patellar and achilles reflexes were not elicited.

Diagnosis.—Epidemic cerebrospinal meningitis with probable meningococcemia was diagnosed.

Course and Treatment.—A lumbar puncture was done on admission, and 30 cc. of cloudy spinal fluid was removed. Laboratory examination revealed: cells, 9,950; polymorphonuclears, 90 per cent; protein, 340 mg.; sugar, 13 mg.; chlorides, 750 mg.; meningococci present in smear; cultures negative for meningococci and other organisms.

During the first five days, the treatment was vigorous and consisted of the removal of from 30 to 50 cc. of spinal fluid every twelve to twenty-four hours together with

1. Vibber, Foster L., and Tartakoff, Joseph: Bubble Technic to Increase the Efficiency of Lumbar Sac Medication, Arch. Neurol. & Psychiat. **26**:1058 (Nov.) 1931.

intravenous and intrathecal administrations of antimeningococcic serum, a total of 120 cc. being administered intrathecally and 100 cc. intravenously. During this time coma and delirium alternated with short periods of consciousness and lucidity. In the right eye there developed an acute iritis with anterior synechiae. The temperature ranged from 102 to 104 F., and the pulse rate averaged 120 per minute.

From the sixth to the twelfth day, there was gradual improvement in all of the meningeal symptoms. Mild mental apathy with periods of clarity replaced the stuporous state. At the end of this period the temperature had declined to 100 F. and the pulse rate to 100 per minute. The spinal fluid became clearer; the cells diminished to 100 per cubic millimeter, with 70 per cent polymorphonuclears; the protein was reduced to 96 mg.; the sugar increased from 13 to 38 mg., and meningococci were absent from smears. A right abducens palsy was present for two days and then disappeared.

In view of the improvement in the meningeal symptoms, the decline of temperature, the absence of meningococci from smears, the favorable change in the cytology and chemistry of the spinal fluid and the negative blood cultures, only 20 cc. of antimeningococcic serum was administered intravenously and 40 cc. intrathecally during this period. The decision to discontinue the administration of serum by the intravenous route was made despite a firm conviction that its use was always followed by a favorable clinical response.

During the succeeding five days, the clinical symptoms remained more or less stationary. Four lumbar punctures were done and 95 cc. of serum was given intrathecally. The right eye continued to be a matter of concern. Although the cloudiness in the anterior chamber became less, chorioretinitis and opacity of the vitreous body developed. Accompanying this there was a rise of temperature to 103 F., and the pulse rate increased to 102 per minute.

On the eighteenth day, there was recrudescence of all clinical symptoms with a rise of temperature to 104.2 F. and increase of the pulse rate to 130 a minute and of respirations to 32. On this date the spinal fluid again became very cloudy, the cell count being 3,000 per cubic millimeter, with 98 per cent polymorphonuclears; it contained protein, 60 mg. and sugar, 8 mg., and meningococci were again present in smears. Coincidently, the right abducens paresis returned and a semicomatose state developed.

Because of the presence of a thick fibrinous exudate in the lumbar region it became extremely difficult to remove fluid or inject serum in the lumbar region.

On the following day the temperature had risen to 105 F., the pulse rate to 134 and the respirations to 32. The stupor deepened, and it became obvious that death was impending. It was then decided to try the combination of injection of air and cervicolumbar irrigation.

Pneumorachioclysis and Cervicolumbar Irrigation.—The patient was anesthetized with gas and oxygen, and placed on his left side with the head supported by a folded pillow so as to be in line with the axis of the spine. Puncture needles were inserted into the spinal subarachnoid cavity at the third lumbar space and into the subcerebellar cistern through the occipito-atlantoid space. As was anticipated, it was practically impossible to secure a flow through the lumbar needle. Only 3 cc. of a thick, amber, turbid fluid, containing large flakes of fibrin, was obtained. After this stood for a few minutes a firm coagulum formed.

The head of the bed was elevated about 45 degrees, and about 50 cc. of fluid was removed from the cistern needle. The stylets were removed from both needles and a 10 cc. Luer syringe filled with sterile saline solution was connected with the cistern needle. This was injected slowly and with gentle pressure, but no fluid

passed through the lumbar needle. The stylet was reinserted in the cistern needle, and about 20 cc. of air was forcibly injected through the lumbar needle, with the idea of dislodging the accumulated exudate, thereby freeing the end of the needle and possibly breaking up any delicate adhesions that might have formed between the pial and arachnoidal membranes. After waiting for about one minute, the stylet was removed from the cistern needle. No air emerged, showing that it had passed cephalad to the cistern.

An empty syringe was then attached to the cistern needle, the head of the bed was lowered to 20 degrees, and 10 cc. of saline solution was injected through the lumbar needle. After gentle suction on the piston of the cistern needle to start the flow, the syringe was allowed to fill itself by the pressure from within. When the cistern syringe was filled, it was removed, emptied and refilled with sterile saline solution, and the procedure was repeated in the opposite direction with the same result. Following this, both syringes were replaced by 50 cc. gravity tubes fitted with rubber tubing and adapters. The head of the bed was lowered to the horizontal. Irrigation with sterile saline solution was continued first in one direction and then in the other until the returned saline solution was clear; a total volume of 300 cc. was consumed in this manner.

Before the manipulations were terminated the patient's head gradually slipped to the side of the pillow with the brow and face down. Bubbles of air began to escape from the cistern needle, and it was decided to leave the head in this position and allow the air to escape. It was hoped that new channels for drainage had been established, and this proved to be the case because, as soon as the air ceased to escape, there followed a fairly free flow of cloudy fluid with flakes of fibrin. It was obvious that the fluid was coming from regions that had not previously been drained, and the head of the bed was again elevated to about 45 degrees to facilitate drainage. As soon as the flow ceased, 50 cc. more saline solution was allowed to flow into the cistern needle and out of the lumbar needle. The procedure was then terminated by the injection of 20 cc. of serum into the cistern and a like amount into the lumbar sac. The patient was then placed on his abdomen and the foot of the bed elevated about 8 inches (20.3 cm.).

This proved to be the turning point and the recovery proceeded gradually from this date, although four more cisternal punctures were done and 160 cc. of serum was injected.

Further Course.—One week after the treatment outlined, the spinal fluid had become clear; the cells were reduced to 34 per cubic millimeter; the protein content was 27 mg.; the sugar content was 30 mg., and meningococci were absent from the smears. Following an injection of 15 cc. of serum into the cistern, on the twenty-sixth day, severe serum sickness developed and coincident with recovery from this there was an exacerbation of the inflammatory manifestations in the right eye, constituting enophthalmitis.

Rupture of the membranes and panophthalmitis being imminent, surgical measures became imperative, and on the thirty-fifth day of the illness (Feb. 19, 1929) the right eye was eviscerated. From material aspirated through a hypodermic needle from the vitreous, meningococci were identified in smear and isolated in pure culture.

From this time on convalescence was steady, the temperature reaching normal on Feb. 21, 1929. The patient was discharged on March 26, 1929, the seventieth day after admission. There was extensive atrophy of the interosseous musculature of the hands, the shoulder and hip girdles and the lumbricales. As soon as the erect posture was assumed lordosis developed, but this was remedied by a brace and cor-

rective exercises. The brace was discarded at the end of three months. At present the patient is in vigorous health and free from sequelae.

The ocular manifestations were due to a meningococcic infection affecting first the iris (iritis), then the ciliary body and choroid (uveitis) and finally the retina and vitreous (enophthalmitis). The recovery of meningococci in pure culture from the vitreous furnishes an explanation for the favorable clinical responses that were noted after the intravenous administration of antimeningococcic serum in the early days of the illness. It justifies the conviction, based largely on clinical impressions, that intravenous serum therapy was indicated despite negative blood cultures.

CONCLUSIONS

1. Presumptive evidence of localization of meningococcic infection outside the central nervous system, in the absence of proof of meningococcemia by positive blood culture, is an indication for intravenous therapy.

2. The injection of a small amount of air into the lumbar sac (pneumorachiocly sis), with the head elevated, may separate pia-arachnoidal adhesions and facilitate the drainage of pockets in the fluid-containing spaces.

3. Complete spinal drainage followed by irrigation of the subcerebellar cistern and spinal subarachnoid space (cervicolumbar irrigation) is a valuable therapeutic measure in certain intractable cases of meningococcic meningitis.

4. Infection of the eye accompanies a certain number of cases of meningococcic meningitis and may constitute a focus for reinfection of the cerebral meninges.

SPECIAL ARTICLE

TRAINING OF THE NEUROLOGIST

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It is a happy idea of the editors of the ARCHIVES to have the problem of the training of the neurologist treated publicly. At present the study of neurology is at a critical stage in its development. Until a short time ago neurology was so intimately connected with psychiatry that their united further development might be considered natural. The therapeutic sense of many nerve specialists has, however, turned their interest in a different direction, namely, surgical. The significance of the work of men like Horsley is now better realized by many, since Harvey Cushing and his school have brought neurosurgery to a high therapeutic level.

Neurology has developed partly from general medicine and partly from psychiatry, and has gradually grown to become a special branch of medical science. A review of how far this growth proceeded in Europe shows that in some countries with universities in larger cities, where the great number of patients makes further specialization possible, independent neurologic institutes and university chairs have been established. The number of these, however, is still small. Hence, several leading neurologists complain that the younger generation in their countries cannot receive sufficient scientific training in this branch of medicine. Neurologic conditions are still treated partly in clinics for general medicine, where biochemistry dominates this phase of scientific investigation, and partly in psychiatric institutes, where psychic disturbances claim the chief interest of the directing professors.

The position of neurology as a special subject of instruction at the university is eminently important in answering the question of how the future neurologist can be trained. Why does this specialty thus far possess so few independent scientific centers? Specializing is also a matter of economy. It is, however, evident that as long as the governing bodies go on building large new departments and institutions for the chief medical subjects, we may find it difficult to expect a solution to the question along economic lines. We must go deeper into the origin of the different teaching departments and turn our eyes to the faculties themselves. It is the duty of the members of the faculty to advise in what direction the medical institutions should be extended, by reporting

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to the authorities in charge how the economic possibilities may best be used.

The organization of the universities may differ in various countries, but their aims and efforts are everywhere the same. The task of a university is not only to promote science, but also to train for the practical learned professions. This last duty is very evident in the case of medicine. The interests of science and instruction usually run parallel, but not always so. There is practically no difference of opinion as to whether scientific theory should occupy a large place during the first years at the university. The basis of medical study must be firmly laid during the preclinical years. The future doctor not only must receive a technical medical training, but has also to be brought to a high cultural level. Furthermore, scientifically endowed pupils have to be stimulated at the university to further study.

During the clinical years, however, the practical side has especially to be emphasized, and now teaching and scientific interests are apt to clash. Through the rapid advance of medical science, the chief clinical subjects are becoming more and more divided into specialties, which are partly developed outside the sphere of the university. Thus a chronic friction arises. The specialists wish to be independently represented within the faculties, and to have their own clinical departments and laboratories. On the other hand, the representatives of the chief subjects, although recognizing the scientific value of specialization, try to prevent too much of this in teaching in the conviction that the medical training of the students is thereby hurt.

Conservatism in man is inborn. This peculiar quality, however, remains latent for a shorter or longer time, according to one's temperament. After the fortieth year it tries almost always to influence one's activities, and forms thus a strong means for self-preservation. The composition of the university faculties is now generally such that the most influential members have already passed this critical stage. The prevailing opinion of many is that the slow advance of medical specialists within the university is to be ascribed to the aforementioned quality. I do not share this opinion, because experience teaches that each well balanced faculty is willing to be enlarged, provided this increase means at the same time a strengthening. The cause must thus be sought for in the specialty itself, and I shall attempt to make it clear why, especially in neurology, only a small number of universities possess independent representatives.

Science is ultimately the result of high intellectual striving. How, then, did those persons work who laid the foundation of neurology, thus making the independence of this subject possible? They did not confine themselves to collecting clinical facts and they did not strive only to widen the surface of their subject. From the clinic they were driven to the more exact sciences, and in this way have given a basis for the

clinical syndromes which may satisfy the most intelligent investigator. It has been their pride that an important part of the normal anatomy, pathology and physiology of the nervous system originated in their laboratories. Those who specialize only in a clinical direction may, from a practical point of view, be of much value to society. They do not, however, impress the members of scientific institutions of learning, because their clinical basis is too narrow, their power of development is too limited and hence they cannot help to strengthen the foundations of the medical edifice. A clinically trained neurologist, however, who also has experience in the anatomy and histopathology of the nervous system and studies his clinical material from the point of view of physiology, is of value to the representatives of the theoretical, non-clinical sections of medical instruction. Whether the emphasis is thereby laid on anatomy or on physiology makes little difference in this connection, provided he contributes through his work to the further extension of these subjects in his special department. A review of the recent development of neurology shows how too much specializing has also made its influence felt here. Many neurologists have acquired great experience in the clinical sphere, but whenever they meet with anatomic or physiologic problems they need the help of others. And many questions in the anatomy, histopathology and physiology of the nervous system which are of value for the clinician are worked out in laboratories without any direct contact with the clinic. One of the chief reasons why neurology so far has so few independent scientific centers is, in my opinion, that the aforementioned combination is seldom found. It takes long to form such men and the demands of practice prevent their continuing the theoretical work.

However, when it is argued that clinical specializing should be combined with studies in the anatomy, histopathology and physiology of this specialty, the following objection should be mentioned. Whenever the therapeutic side of a subdivision of medicine requires a special capacity, it becomes necessary, on humanitarian grounds, that this specialty be acknowledged by the university. The value of nerve specialists in the sphere of therapeutics depends chiefly on the fact that they have considerable psychotherapeutic experience and in the second place on their ability to give surgical advice when an operation has to be performed.

The so-called neuroses and psychoneuroses have always been the most fruitful field for psychotherapy. As our knowledge is less exact as to what really happens in such cases, the method of therapeutic approach varies considerably. It is evident that this side of therapy cannot aid neurology in getting scientific centers of its own. The psychotherapeutic faculty is not the privilege of neurologists, because many other physicians also have this power, especially those well versed in psychologic

and psychopathologic science. There is even a tendency in several neurologists to concentrate totally on organic neurology and to leave the psychoneuroses to the psychiatrists. In my opinion this is wrong. Many diseases of the internal organs and many organic conditions of the nervous system pass through an early stage in which no organic symptoms are to be found. When attention is concentrated on the psychic side, there is usually a danger that somatic diseases will be overlooked. Thus, much wrong and harm are done to the patients. Besides, in the history of medicine many examples are to be found showing how, by technical improvements and more careful clinical discrimination, organic diseases are separated from the group of neuroses. Therefore it is necessary for neurologists who are well trained in the knowledge of the anatomy and physiology of the brain to maintain their interest in the neuroses.

It is undoubtedly true that the natural science method of thinking—that of the anatomists and physiologists, for example—hinders the psychotherapeutic influence. The doubt, thus raised, stands in the way of one's own sure belief. A sense of certainty gives the best chance of a successful psychic influence over the patients. Experience, however, teaches that the desired aim may, in a given case, be reached by ridding oneself of physiologico-anatomic ideas, applying the suggestive measures needed and concentrating on the psychic state of the patient.

Neurology is in a difficult position at present with regard to surgery. The position in Europe has long been that the neurologist indicated the operation, while the general surgeon performed it. When the cooperation was sufficient and the general surgeon had much interest in the nervous system, the results were fairly good. In general, however, the advance —especially in surgery of the brain—was not striking. Only few surgeons in Europe followed Horsley. Partly owing to unsatisfactory results and partly because they had an inclination to surgical activities, several neurologists began to take up the knife themselves. Above all, O. Foerster showed that new results in therapeutics may be obtained in this way. Meanwhile a whole school of surgeons had been formed in the United States, the members of which concentrated their attention on the nervous system. Soon after the war, when international scientific intercourse had been restored, many crossed the ocean to see with their own eyes the progress reached by this neurosurgical school. This caused a sense of disquiet in the neurologic world. The voices of those who wished to have a larger number of neurosurgeons in Europe became louder. Several prominent neurologists desired that the younger generation be trained in neurosurgery. It was argued that in this way neurology had a chance of acquiring an independent position within the universities. Ophthalmology and otology obtained their own place

through special surgery, and neurology must do the same. The neurologist should overcome the opposition of the representatives of other subjects by showing that he could attain better therapeutic results than the general surgeon. Although sympathizing with such a contention, I yet predict that the effort to reach the desired independence in this way will meet with much difficulty. In his struggle for university centers with such a weapon, the neurologist will have not only the psychiatrist and the internist but, fraternally united, the surgeon also as opponents.

Meanwhile, in the present state of neurology a cardinal point of training is here involved. Shall this training continue to be given in close touch with psychiatry and general medicine, or will it rather have to turn to the surgical side? Must the future neurologist be a "physician" or a "surgeon"?

If neurology has to move in a surgical direction, the interest in the group of patients not needing operative treatment will become less. The field of differential diagnosis, one of the glories of our subject, will become much narrower and hence will be checked in its development. Research in the normal and abnormal structure of the nervous system, especially that of the brain, will retain the interest of neurologists only so far as it is connected with practical surgical problems and with the nature of the extirpated tissues. The field of neuroses and psychoneuroses will have to be left wholly to the psychiatrists. The overlapping field of general medicine and neurology will hardly be trod any more. Furthermore, neurosurgery is not a *petit chirurgie* (minor operation), but for the most part consists of big operations. An increase of the material, which every neurosurgeon strives to obtain, will, on purely physical grounds, render it impossible to follow the development of neurology to its full extent. On the other hand, it is certain that the increase of neurosurgery as a separate sphere of activity ought to be encouraged, because the therapeutic results must show an upward tendency. Neurologists have to see to it that this is done, because general surgeons will consent hesitatingly to the loss of such important material from their teaching departments. What is more, they feel that when the neurosurgeon is once there, he will try to enlarge his field of activity and to win the territory of the peripheral and of the autonomic nervous system.

Every neurologist who has to bear responsibility of training the young generation will have personally to find a solution of the difficulties raised here, provided at least that he considers the foregoing points as difficulties. Local circumstances, differences in the organization of instruction, in the traditions of special countries and in the ambitions of the leading neurologists, will cause such a solution to be varied.

Hence in my opinion, the editors of this publication did well in inviting representatives of neurology in different countries to state their points of view.

ORGANIZATION OF NEUROLOGIC CLINIC V

In the following pages I shall relate the way in which I have solved in practice the aforementioned problems. Some years ago circumstances permitted me to reorganize the study of neurology and the training of neurologists at the University of Amsterdam. In preparing the plans I saw distinctly not only that the new center must contain everything needed for the up-to-date examination of patients and for scientific research in the lines hitherto followed in the clinic, but also that therapy must in every respect have justice done to it, in particular with regard to surgical treatment. As to the latter it was evident that I could not follow the example of those colleagues who took charge of neurosurgery themselves, however attractive that might appear. I lacked talent and training for that, and the theoretical problems in which I was engaged bound me too much. I did not like to cut the branch of the tree on which I was sitting. The position of "hands off" in the operating room seemed safest. At the same time I cherished the hope that, smoking a cigaret in my laboratory and reflecting on the difficulties and problems that might emerge at the operating table, I should be able to do more for neurosurgery than in attempting its actual practice. A surgeon had thus to be appointed a member of the staff. After special training, he should be able to perform independently the various operations on the nervous system in our clinic. Such a surgeon who had a good training in general surgery and who at the same time was a neurologist and member of the staff, was found willing to accept this position (I. Oljenick). After he had received special education in the clinic of Harvey Cushing at Boston, and after the building was completed, the new institute was opened, on Aug. 15, 1929. It is a part of the large University Hospital, with its 1,700 beds, and is situated, symbolically as it were, between the psychiatric clinic on the one side and the clinic for general medicine on the other. It contains one hundred and eighteen beds for the University section and seven for private patients. Besides the wards there are separate examination rooms and places for physical and electrical treatment and hydrotherapy. Massage is done by blind masseurs. There are an aseptic and a septic operating room, with additional spaces for washing and sterilization. The laboratory for roentgen examination adjoins the aseptic operating room. There is a laboratory for practical routine clinical work (examination of the spinal fluid and blood and simple chemical analyses). Bacteriologic and serobiologic investigations are made in the general laboratory of the hospital. Large laboratories have been erected for research work in the anatomy, experimental anatomy

and histopathology of the nervous system. In addition there is a separate laboratory for the experimental physiology and electrophysiology of the nervous system. In the University Institute for pathology, situated a short distance off, a separate part of the building is reserved for animals used in neurology. The experimental work is performed partly there, partly in the Neurological Institute. There is a library containing numerous works on neurologic and neurosurgical subjects. The lectures are given in the adjacent psychiatric clinic. The outpatient department is in the immediate neighborhood of the hospital. My private room is situated in a corner at the top of the building. Hence it is difficult for those who like talking to reach me.

The clinic is no palace, as is so often found. It is perfectly clean—Dutch tradition—but there is very little marble in it. The careful observer will, however, see that here we have a neurologic clinic, where the old and new times meet and where the old and new worlds are no longer separated by the ocean. The staff is composed as follows:

Director, who also lectures at the university
Chef de clinique, substitute director
Two resident assistants
Nonresident assistant in the laboratory
Neurosurgeon
Resident assistant
Voluntary assistant
Two assistants in the outpatient department

Besides the nurses, who are under the supervision of the director of the hospital, there are four technical workers available for research.

The separation between the neurologic and neurosurgical departments is not sharply defined. The method of work is as follows. With certain exceptions, each patient is first examined in the neurologic department, where his history is taken by the resident assistant in cooperation with the students. Should it appear that neurosurgical aid must be considered, the patient is referred to the neurosurgeon. This is the case with ± 30 per cent of the material. The patient's history is then taken anew, but is now based on the principle of localization. It is my firm conviction that the neurosurgeon must examine his patients himself and not depend exclusively on the opinion of the neurologist. If necessary, he completes the roentgen examination, which has been done in the general roentgenologic department of the hospital, by stereoscopic work of his own. He also performs a roentgen examination after the injection of air or iodized poppy seed oil 40 per cent. After an exchange of views between the neurosurgeon and myself it is decided whether an operation is necessary or not, and the method of approach is discussed. The extirpated material is examined histologically in the laboratory of the neurosurgical department. If surgical advice is required on diseases outside

the nervous system the cooperation of the general surgeon of the hospital is sought and, if necessary, he performs the operation in his own department.

Students of the university work daily in the clinic and in the outpatient department for six weeks. Before this they have attended the classes in clinical neurology and neuropathology. As they have had to pass an examination previously, they are theoretically far enough advanced to do the practical work successfully. The members of the staff instruct them at the bedside. Among these students there are always some who, after graduation, try to get an assistantship at the clinic. A choice of these is made. Previous experience as a resident assistant at a clinic for general medicine is a recommendation but not indispensable. Personality is the chief thing. If these assistants wish to become nerve specialists or psychiatrists—which is not always the case—they remain at the clinic for two years. Thereafter they try to get a position at a psychiatric institute. In this way the disadvantage of having to be trained in neurology and psychiatry separately is overcome. The professor of psychiatry at our university prefers those with neurologic experience. It is imperative that every assistant who is later to become a nerve specialist undergo a proper training in psychiatry. During the psychiatric education it will be evident where his talent lies. For those also who will later work as psychiatrists in the asylum or will practice as psychopathologists and psychotherapeutists, a neurologic basis is no mere luxury.

Research work has to be done because of love, not duty. If the neurologic assistant is attracted by the research work in the institute, he is given an opportunity to do this. In this case he remains longer at the clinic and may receive a more fundamental scientific training.

Since the opening of the new institute, this line of education, which has been followed for several years at our university, may be completed by a neurosurgical training. In the first place, the assistants in the neurologic department, owing to the close cooperation with the neurosurgical group, acquire a better knowledge of the possibilities that modern surgery offers. In this way they collect experience that will be of value when they are established as nerve specialists outside the university center.

In the second place, some doctors who are attracted by neurosurgery find it possible to develop themselves in this direction. The question as to whether the future neurosurgeon must have an intensive training beforehand in general surgery is difficult to answer. I am aware that several neurosurgeons take the stand that such service should be short, so that they have to unlearn less. The neurosurgeon at my institute does not regret his long training as a general surgeon, nor do I. It appears

to me that this broader basis is desirable for the further development of neurosurgery. In this way the possibility of expansion of the field of activity is enlarged. Experience has still to teach how long a special neurosurgical training is necessary. Everything depends on the individual.

In the foregoing pages I have sketched the motives that led me to organize the neurologic center described, where neurologists of different types may be trained. This institute forms a unit, as diagnosis, therapy in the widest sense of the term, teaching and research are combined. It still satisfies me. *Beati possedentes.* The sense of satisfaction must not, however, hinder further evolution. One must have an open mind for advances in medicine. The great progress in biochemistry insures that neurology will also in due course reap benefits from this. At the time of the reorganization I did not consider that this moment had already arrived. I believe that emphasis must first be laid on neurosurgery. My ideas about the training of neurologists are now realized at Amsterdam. It is not for me to insist that such an organization is the correct one, but I am ready and willing to face criticism.

News and Comment

ASSOCIATION FOR RESEARCH IN NERVOUS AND MENTAL DISEASE

At the annual meeting the following officers were elected to serve in 1933: J. Ramsay Hunt, 46 West Fifty-Fifth Street, New York, president; Dr. Thomas K. Davis, 70 East Seventy-Seventh Street, New York, secretary-treasurer.

The next scientific session, to be held in December, 1933, will deal with the topic, "The Biology of the Individual." The program provisionally arranged for will first cover various constitutional problems, ranging from the rôle of heredity in constitutional expression to morphologic, physiologic and neurochemical aspects of constitution with the inclusion of what is considered to be normal in the biology of the individual. The second day's program will move into the psychologic panel, as indicated by such titles as "The Body-Mind Problem," "Psychological Development of the Individual in Infancy" and "Comparative Psychology and Constitution." Sociologic aspects of the subject will dominate the afternoon of the second day.

The topic selected for the 1934 meeting of the association is "Sensory Disturbances." This program will be under the directorship of Dr. T. H. Weisenburg.

THOMAS K. DAVIS, *Secretary.*

Editorial

TRAINING OF THE NEUROLOGIST AND THE PSYCHIATRIST

For the future neurologist and psychiatrist there is nothing of so much importance as the present determination of the proper method of his training, for the practice of neuropsychiatry has undergone great changes in the last thirty years. At the beginning of this century the neurologist assumed all responsibilities. Patients in need of surgical treatment came first to the neurologist, who referred them to the surgeon; the operation was done under the close scrutiny and direction of the neurologist. Now, most of such cases are referred directly to the neurosurgeon, who makes a diagnosis and operates without the advice of the neurologist.

Neurosyphilis was not a particular therapeutic problem three decades ago; it was easy to prescribe mercurial inunctions and iodides. Since the advent of the arsenicals, however, the syphilologist treats such patients, but this is part of a general problem in which all specialties suffer.

Infantile paralysis, the meningitides and acute infections of the nervous system are now being treated in part by the pediatrician, the internist and the serologist, chemotherapy being the last specialty to be born. In this regard it is proper to point out that there is a tendency for the laboratory specialist to be guided in his treatment by the test tube rather than by the condition of the patient.

Treatment for the psychoneuroses was comparatively simple thirty years ago; psychoanalysis was in its infancy. Since then have come not only the philosophies of Freud and other leaders in this field, but also the era of focal infections, with its attendant evils, and of the endocrinopathies. Today, the psychoneurotic person, frequently without the benefit of a medical survey, may on his own initiative select treatment by a psychoanalyst, who is not always a physician, or perhaps place himself in the care of some "psychiatric institute" for a pleasant regimen of physical therapy and dietary regulation.

Thirty years ago psychiatry was concerned solely with the study of the psychoses; mental hygiene, child guidance and social psychiatry had not been born. The urge toward instructing the public by popular books and radio talks in the intricacies of what is called mental hygiene had not been felt. Many psychiatrists today claim that the study of and treatment for the psychoneuroses belong within their realm because, being trained in the study of mental mechanisms, they are better

equipped than are the neurologists. Lastly, the psychologists, without medical training of any sort, though often with a certain knowledge of the patter of neurology, psychiatry and psychoanalysis, claim that they can adequately treat patients with psychoneuroses and psychoses; at times even an organic disease—whether recognized or not—is not beyond their ability.

There is no question that the present trends have had a direct influence on the scope of scientific research. There has never been a time when progress in organic neurology, particularly in the physiologic field, has been more flourishing than it is today. This is well exemplified by the type of articles appearing in this journal. On the other hand, psychiatric research leaves much to be desired.

That these trends are well recognized needs no elaboration. Have such changes been of value? Some undoubtedly have. There is no doubt, however, that for the best interest of the patient and for the future progress of knowledge, the treatment of the acute infections of the nervous system and neurosyphilis should be in the hands of the neuropsychiatrist. There is also no doubt that the tendency to split this specialty has not been of benefit, for the neurosurgeon, the psychiatrist and the neurologist—if they desire to be well grounded—must have a training in each. In the hope of throwing some light on this problem, the ARCHIVES has asked some outstanding leaders both abroad and in this country to express their opinions. The first of these articles appeared in the February issue (Walshe, F. M. R.: Training of the Neurologist, ARCH. NEUROL. & PSYCHIAT. **29:** 368, 1933); the second, (Brouwer, R.: Training of the Neurologist) appears in this issue, page 624.

Obituary

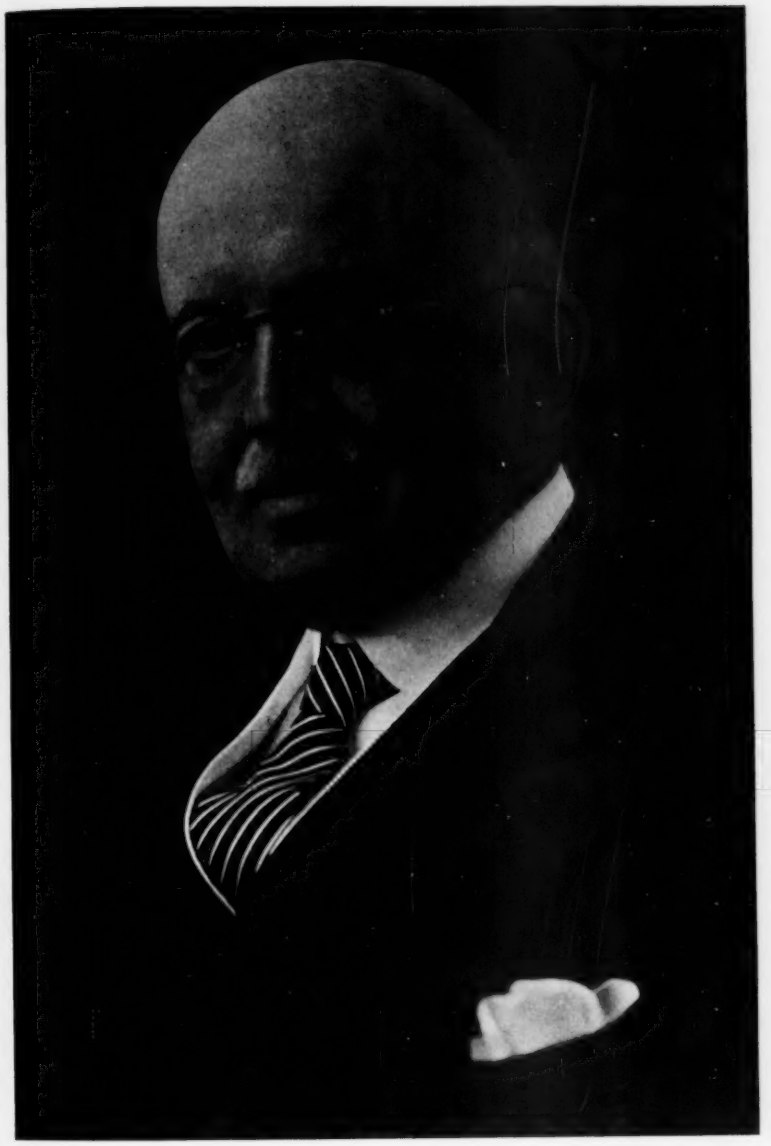
EDWARD NATHANIEL BRUSH, M.D.
1852-1933

Dr. Edward Nathaniel Brush, for many years an outstanding figure in American psychiatry, died of pneumonia at his home in Mount Washington, a suburb of Baltimore, on Jan. 10, 1933, after an illness of five days.

Dr. Brush was born at Glenwood, Erie County, New York, on April 23, 1852, the son of Nathaniel Howland and Myra Theresa (Warren) Brush. He selected medicine as his profession and graduated with honor from the Medical Department of the University of Buffalo, on Feb. 24, 1874, his thesis "Upon Syphilitic Affections of the Nervous System" being published by vote of the faculty in the *Buffalo Medical and Surgical Journal* for October and November, 1874. He was office student and, after graduation, assistant to Dr. Julius Miner, an eminent surgeon, and later, assistant to Dr. James P. White, a gynecologist. He also served as visiting physician to the Buffalo Hospital of the Sisters of Charity.

His induction into psychiatry was somewhat a matter of circumstance. In 1878 it was necessary for him to change his offices, and he planned a vacation with postgraduate study in Boston with Reginald H. Fitz. Before arrangements were completed he was asked to take a temporary position at the Utica Asylum, then under John P. Gray. Because of the opportunity to learn laboratory technic under Theodore Deecke, Dr. Brush accepted this position. At the end of the summer he had become so much interested in mental cases that he became an assistant physician, and remained at Utica until December, 1884, when he was appointed first assistant physician in charge of the men's division of the Pennsylvania Hospital, Department for the Insane. He continued there until 1891, when he was appointed superintendent of the Sheppard Asylum, then under construction at Towson, Md. Under his wise administration this hospital grew in size and prestige. In 1898 its name was changed to The Sheppard and Enoch Pratt Hospital, in accordance with a bequest from Mr. Enoch Pratt, who had admired the manner in which Dr. Brush had conducted the hospital and felt that its resources needed strengthening. Dr. Brush retired from this position on Jan. 1, 1920.

Dr. Brush was always a prominent worker in medical associations in Buffalo, Philadelphia and Maryland, as well as in the American Psychiatric Association. In 1915 and 1916 he was its president. He was also president of the Medical and Chirurgical Faculty of Maryland in



Very Sincerely Yours
Edward N. Brush

1905, and president of the Baltimore County Medical Association and of the Maryland Mental Hygiene Society.

Early in his medical career Dr. Brush began to record his observations, and his bibliography is long, including contributions to the first edition of Wood's "Reference Handbook of the Medical Sciences," Hare's "System of Practical Therapeutics" and Keating's "Encyclopedia of the Diseases of Children." It was as an editor, however, that the greater part of his literary work was done. Soon after his graduation in medicine he became an associate editor of the *Buffalo Medical and Surgical Journal*. While at Utica he was on the editorial staff of the *American Journal of Insanity*, then owned by the Utica State Hospital and printed by the Utica Hospital Press. This work was discontinued on his removal to Philadelphia, but he became a member of its editorial board in 1897, and its editor in 1905, and he so continued until 1931, when he became editor emeritus, although he kept up a part of the work he had done so long and took an active interest in it until his last illness.

Dr. Brush was appointed professor of psychiatry at the Women's Medical College of Baltimore in 1896, and held this chair until he accepted a similar position at the College of Physicians and Surgeons of Baltimore in 1899, continuing here after the college affiliated with the University of Maryland. He was made emeritus professor in 1920.

Dr. Brush was a member of a number of social organizations at various times, such as the University Club, Sons of the Revolution, Baltimore Country Club and Authors' Club of London. He was also an honorary member of the Medico-Psychological Association of Great Britain and Ireland and of the Société de Médecine de Belgique, foreign associate member of the Société Médico-Psychologique of Paris and associate member of the American Neurological Association.

Though nearly 81 years of age, Dr. Brush was "younger" than many men of 65. Possessed of a keen, active mind, with a fine memory, he took an interest in many subjects. He had a large medical library and was a facile reader. His major hobby was photography, which he pursued for many years and in which he was interested to the last. The illustrations which adorned the reports of the Sheppard and Enoch Pratt Hospital during his régime were all his work. He was one of the first to take up color photography, and he followed its development closely. After his retirement he took an active interest in gardening.

In his long life Dr. Brush influenced many people and conditions for good. Many of the younger men who served with and under him received from him the stimulus which caused them to reach positions of eminence. Dr. Brush was a steadfast friend, most sympathetic with one's troubles and helpful with advice. Those of us who knew him well and loved him will miss his cheery presence.

William Rush Dunton, Jr., M.D.

Abstracts from Current Literature

CASES OF POSTVACCINIAL ENCEPHALOMYELITIS OBSERVED IN HOLLAND TO JANUARY 1, 1929. F. S. VAN BOUWDIJK BASTIAANSE, Ztschr. f. d. ges. Neurol. u. Psychiat. **134**:657 (July) 1931.

Until the recent report of cases of encephalomyelitis, the chief complications known to follow vaccination were tuberculosis, syphilis, erysipelas, septicopyemia and tetanus. The earliest case which Bastiaanse could find of vaccination followed by encephalomyelitis was in a child who was vaccinated in 1900, at 6 years of age; convulsions and unconsciousness developed, lasting for twelve hours, and following this the patient was paralyzed on one side. Apparently he has recovered, and he shows no ill effects. Another early case was that of a child, aged 6, in whom, in 1903, following vaccination, paralysis of the right side and paresis of the left side developed, with absent patellar and achilles reflexes. Since the relation of vaccination to infection of the central nervous system was not appreciated at the time, her trouble was attributed to a slight trauma experienced prior to the illness.

Bastiannse found the following cases in the foreign literature before 1925: Thaning reported the case of a girl, aged 6, who was vaccinated in school; then there developed a gradually progressive paralysis of all the muscles, absent patellar and achilles reflexes, but no other positive findings. The patient gradually regained power in the extremities; all traces of paralysis disappeared, and she completely recovered. In a case of Finkelstein there developed in an infant, aged 1 year, one week after vaccination, hyperesthesias, opisthotonos, slight stiffness and twitchings. All the symptoms disappeared with the drying up of the vaccination. Similar cases were recorded by Freud (1897) and Comly (1906). Luksch (1924) reported 3 cases in which there developed what he thought were encephalitic symptoms ten days after vaccination. The brains showed the changes observed in the acute stages of encephalitis. Luksch was unable to find anything in the cases which was peculiar to the effect of vaccination, though he recognized the relation between the clinical symptoms and the vaccination.

The first cases of the disease in Holland were observed in 1924. One was in a child, aged 5, in whom meningeal signs developed eleven days after vaccination; the child recovered, and the diagnosis made at the time was encephalitis. The other case was that of a boy, aged 5; headache, coma, meningeal signs, hypertonicity and a Babinski sign developed about one week after vaccination. These cases were reported by Bastiaanse, who suspected some relation to the vaccination, and who asked for similar reports from physicians in Holland. These cases were recorded in a central bureau, and there is available, therefore, a complete list of the cases in the country. Neurologists, internists and pediatricians were enlisted in an effort to report all cases. There has been an effort also to record all cases in infants of from 4 months to 1 year of age who die within a month after vaccination. This is still being done.

There were in Holland up to Jan. 1, 1929, 138 undoubted cases of encephalomyelitis following vaccination. Of these patients, 69 were male and 69 female. The ages ranged from 4 months to 7 years. Forty-three patients died, 23 male and 20 female. In Holland the reaction took place on an average of from seven to nine days after the vaccination, at a time when the pustule was most active. This reaction was not marked. Between the vaccination and the first definite symptoms there was an average incubation period of from nine to thirteen days. The disease set in rapidly, and within a few hours the complete clinical picture had developed. The first symptoms were headache (27 times), vomiting (39 times) and fever (75 times). Immediately following these were disturbances in consciousness (96 times) manifested as drowsiness, somnolence or coma. In addition,

there were convulsions (48 times), stiffness of the neck (54 times) and a Kernig sign (39 times). During this and the following period, symptoms and signs appeared which were referable to the pyramidal tract: Babinski sign (76), hypertonia (27) and hemiparesis (8). Spinal cord signs (38 times) were: retention of urine, loss of abdominal, knee and achilles reflexes, paraplegia and flaccid paralysis. Signs of involvement of the cranial nerves were: ocular palsies (15), facial paralysis (8), ptosis (7) and lingual paralysis (3). Other signs occurred as follows: hyperesthesia (30), trismus (16), marked secretion of sweat (9), hypotonia (5), mental disturbances (6), ataxia (5), tremors (5), opisthotonos (4), choreiform movements (4), nystagmus (3), aphasia (3), catatonia (2) and hemianopsia (1). There were mild changes in the spinal fluid in 15 cases.

It has been said that encephalomyelitis following vaccination never occurs before 1 year of age. Bastiaanse analyzed a series of cases at various age levels, ranging from 4 months to 7 years. He concludes that the diagnosis in very young children will always be difficult, because signs like those of Babinski, Kernig and Brudzinski, incontinence and mild paresis have no value, while convulsions occur in all sorts of children's diseases. On the other hand, true forms of the disease may go undetected. If in an infant fever, vomiting, somnolence, stiff neck, convulsions, paresis, tonus changes, tremors and choreiform movements occur after vaccination, one can establish a diagnosis without question. If the infant dies within a month after vaccination, encephalitis must be considered, even when the signs are referable to other organs. On the other hand, one must not be too hasty with the diagnosis, particularly in cases with fever and vomiting on the seventh day, with or without convulsions, followed first by more or less amelioration and later by typical encephalitic phenomena.

The most important treatment is active vaccine therapy based on the work of Gordon, who showed that the serum of animals inoculated with pox vaccine established a passive immunity against vaccine. If 1 cc. of this serum is injected subcutaneously into a rabbit and then injections of pox virus are made into the rabbit on the next day, no pustules develop. Bastiaanse had such a vaccine prepared in Holland. Of 17 patients treated with a vaccine, 5, or 29.04 per cent, died. The mortality when serum is used is a little higher, therefore, than when it is not used. The number of cases is too small to warrant absolutely final judgment. In any event, there is no particularly favorable effect of serum therapy in these cases of encephalomyelitis. In a case in which serum therapy was instituted, even within twenty-four hours after the onset of the disease, the patient died. Of 3 patients treated with a vaccine 1 showed immediate improvement.

Bastiaanse was able to study the brain in 2 cases. Macroscopically, only mild hyperemia of the pia and congestion of the vessels in the white matter were present. Microscopically, the brain showed numerous perivascular foci, chiefly in the white matter, and everywhere in the cerebrum and in the cerebellum, pons, cerebral peduncles and brachia pontis. There were no foci in the cerebral nerves. Perivascular foci were present here and there in the cerebral cortex, chiefly in layers five and six. The foci were not numerous in the basal ganglia. On the other hand, the mesencephalon showed a marked, diffuse increase of cells, particularly in the red nuclei, the substantia nigra and the pontile nuclei.

There is an apparent difference between the foci in the telencephalon, the cerebellum, the peduncles and the brachia pontis, on the one hand, and in the gray substance of the brain stem, on the other. The foci in the telencephalon and in the white substance of the brain stem is almost entirely perivascular. Where the foci are not found around a vessel in these areas, one can establish a close relationship to a vessel. The perivascular infiltrations are wide and pass over into the white matter imperceptibly. There are no leukocytes; lymphocytes are very few and are either within or immediately around the vessel. Here and there plasma cells are seen. The great majority of the cells around the vessels are microglia and astrocytes. The foci in the gray matter of the cortex have a similar character. No changes were noted in the cortical cells themselves, except for occasional evidence of neuronophagia. The foci in the gray substance of the brain stem have a little different character. In the red nucleus and substantia

nigra particularly, one finds numerous degenerated ganglion cells. In these nuclei are areas in which not a single normal ganglion cell is to be found. The blood vessels, on the contrary, show relatively slight perivascular infiltration. Many of them show none, while others have only a mild infiltration within their walls, chiefly of lymphocytes and plasma cells. One gains the impression that the glial mantle is found mostly in the white matter, and that in the gray the mesodermal reaction is the more pronounced. Weigert preparations show a loss of myelin sheaths around the vessels.

A comparison of Bastiaanse's findings with those of other workers brings out some interesting points: 1. With regard to the spread of the disease through the nervous system, all investigators confirm the finding that the white matter is widely affected. Turnbull and McIntosh (1926) said that the gray matter is more affected than the white, but that the latter is greatly involved. To them the characteristic feature is the demyelinization. Luksch believed that gray and white matter are about equally involved by the inflammatory process. Perdrau said that the white substance of the cerebrum and cerebellum is more involved than the gray. Bouman and Box found the foci chiefly in the white matter; Wiersma also found them most commonly in the white substance, as did Pette. One may conclude, therefore, that there is marked involvement of the white matter, and that in some cases the gray substance is only slightly affected. 2. As to the nature of the foci in the white matter, all investigators agree that those in the white matter are principally extra-adventitial. They are wide and pass into the brain substance. They are composed of microglia and some astrocytes containing fat droplets, which are the result of the destruction of the myelin sheaths. 3. There are differences of opinion concerning the involvement of the gray matter. Wiersma reported the most widespread involvement in 1 of his cases that showed neuronophagia in the pallidum, caudate and thalamus and the entire gray substance. In his 2 cases, Bastiaanse found extensive neuronophagia in the red nuclei, the substantia nigra, the reticular nuclei and the nucleus lemnisci lateralis. Luksch described degeneration of the cells in the substantia nigra. Turnbull and McIntosh often found tigrolysis, but seldom complete necrosis. They found some loss of cells in the anterior and posterior horns in their case 4, but no neuronophagia. Bouman and Box found no changes in the ganglion cells. Several authors have pointed out that the ganglion cells may be entirely normal in the demyelinated areas. It may be concluded, therefore, that although the disease has little tendency to attack the ganglion cells per se, they do not remain unaffected, and in some cases may be markedly affected. 4. Inflammation in the leptomeninges is slight or absent. Turnbull and McIntosh said that it is relatively slight and insignificant. Lymphocytes, plasma cells and hyaline cells are seen around the veins. Perdrau found the infiltration of the meninges very mild, but cell accumulations around the vessels were not uncommon. Wiersma found only hyperemia of the meninges. Bastiaanse found only scattered groups of lymphocytes around the vessels. 5. Inflammatory evidences in the adventitia of the blood vessels are uncommon. Luksch found lymphocytes, plasma cells, polynuclears and endothelial cells in the vessel walls. Wiersma found polynuclears in 1 case. Perdrau found lymphocytes and plasma cells most frequently in the perivascular spaces. According to Turnbull and McIntosh the perivascular foci are composed of lymphocytes, plasma cells and mononuclear leukocytes. 6. The spinal cord has not been studied thoroughly in many cases. Turnbull and McIntosh found inflammatory processes in all levels; they are slight in the upper cervical area, and marked in the fifth cervical level. Inflammation is most marked in the lumbosacral area, where it involves both gray and white matter. Perdrau found the process most intense in the lumbosacral area also. 7. Perdrau found demyelinization in the anterior roots of the ninth thoracic nerve, and inflammatory phenomena in the distal end of the left brachial plexus. Perdrau found a mild infiltration of lymphocytes and plasma cells in the spinal ganglia. The optic nerve and tract were injured in Schurmann's case.

Encephalomyelitis following vaccination appeared sporadically before 1924, but instances have been more numerous since than before that time. The average

time of appearance of symptoms was eleven days after inoculation. Most of the cases occurred in February and March; the number fell off markedly in May. The number of inoculations does not in itself explain these tendencies, because in October, June and September, when there were as many inoculations and more than in February and May, the incidence was low. Older children are more apt to be attacked than younger. Males and females are equally affected. Of 191 patients, 91 were males and 100 females. In 2 instances more than 1 case appeared in the same family. Often, several patients were inoculated by the same physician, but it must be remembered that in country districts all the work is carried out by a single physician; this may, therefore, mean little. Vaccine virus was used from stations in Paris, Vienna, Bern, Hamburg and other places in Holland, and with every strain cases of encephalomyelitis followed. In an instance in which vaccine virus imported from Sweden was used, 3 cases of encephalomyelitis developed, whereas following the employment of the same virus used in Denmark not a single case of encephalomyelitis occurred.

As to etiology: 1. One group of investigators looks on the vaccine virus itself as the cause of the disease (Luksch, Netter and Jorge), and their belief is that the vaccine virus has become more potent in later years. They lay much stress on the finding of vaccine virus in the brain of postvaccinal encephalomyelitis in a case of McIntosh and Turnbull. Objections to this idea of the etiology of the disease are that rabbits into which injections of vaccine virus have been made have pustules in all organs and possibly least of all in the brain, that the experimental encephalomyelitis differs histologically from that found in man, and that the number of cases has no connection with the virulence of the vaccine. 2. Others believe that the encephalomyelitis is due to another virus, which may be latent in the organism and be aroused to activity by the decreased resistance of the body caused by the vaccination. 3. Others believe that the encephalomyelitis is due to a mixed infection.

ALPERS, Philadelphia.

THE LAW OF "FORGETTING" (RIBOT'S "LAW"). M. WEISSFELD, Jahrb. f. Psychol. u. Neurol. **44**:302, 1932.

Weissfeld stresses the importance of distinguishing memory from apperception. This paper deals only with disturbances of memory. Negative memory defects (failure of memory) must be differentiated from positive memory defects (faulty memory). A person who forgot six of ten exposed words and two of ten exposed colored figures would be considered as having a simple failure of memory for these words or figures. Should he, however, later be able to identify correctly five of the exposed colored figures and, in addition, three figures which had not been shown to him, his memory would be regarded faulty. Extensive faulty memory may be associated with confabulations.

Disturbances of memory may also be divided into general and special, or circumscribed, defects. Among the latter are included more or less sharply limited islets of memory defect. A loss of memory for colors with retention of other memories, or the complete vanishing of a definite period of life from memory would be examples of a special memory defect (retrograde amnesia). In general weakness of memory there occurs a diffuse "degradation" of memory. Biologically, a general loss of memory may be said to be analogous to blindness in general, and a special loss of memory to blindness for colors. Although there are great variations in general as well as in special disturbances of memory, nevertheless both of these types of memory disturbances are subject to certain laws. Thus, whereas general memory disturbances appear gradually, a gradual diminution is not characteristic of special memory disturbances. In this contribution, only the rules of general memory disturbances are discussed.

Another classification of memory defects is based on the element of time, so that one speaks of memories for most recent events and memories for remote events. In speaking, however, of memories for most recent events one does not mean as recent as a period of seconds; in contrast to the content of apperception, it is a matter of much longer intervals of time.

A gradually progressive diminution of the general memory may be interpreted as a failure of memory first for remote occurrences, which goes on to a failure of memory for recent occurrences. Or, it may indicate that the gradual failure of memory begins with most recent events and gradually affects memory for past events. Most psychiatrists believe the latter to be the case. It is generally assumed that loss of general memory occurs in a direction opposite to that of the acquisition of perceptions. Thus, Ribot's formulation of the law of regression of memory is that the process of forgetting begins with the recent past and later affects the remote past. Weissfeld, however, states that it is not so easy to determine whether Ribot's law applies to all general memory defects or only to those of certain diseases, although he admits its applicability to senile dementia, dementia paralytica, cerebral arteriosclerosis and normal senility. His objections to Ribot's theory are numerous. First, it is paradoxic; that is, it is contrary to intelligent memory requirements and habits. An expression commonly heard is: "I have already forgotten it; it happened so long ago." One could, however, say: "I have already forgotten it; it happened only recently." But such an expression would be most illogical. Aside from this, Ribot's theory is also defective methodologically. In order to formulate it correctly, the two components of the theory—a relative retention of memory for past and a poor memory for recent occurrences—must be considered separately. The theory is based on an emphasis of positive findings. It is impressive when an aged person can recall a beautiful book presented to him by a fellow student during their school days. From a detailed description of the book by that person one may draw the erroneous conclusion that occurrences during childhood are well remembered, whereas, as a matter of fact, the memory for this particular event is retained because at the time of its occurrence it was associated with some unusual emotional reaction. When one attempts to analyze his own memories one usually finds that he has forgotten innumerable occurrences of childhood. It is strange that in estimating the memory of other persons one should lose sight of this well established fact.

It seems that negative facts are entirely disregarded in this connection. If this were not the case it could readily be found that when they are subjected to direct questioning aged persons forget a great deal of the past. As a rule, the aged have islets of memory defects for past events, because they are mere islets.

It must also be recalled that the relatives of an aged person notice more readily his defects for recent events. The reason for this is the existence of practical points of contact in the sense of an existing common interest between the aged person and those who are in immediate contact with him. Memory defects for recent occurrences are thus more conspicuous than defects for past events. When, for example, an aged person has forgotten that the physician visited him a year ago, the latter is immediately struck by this because he knows that he had actually visited him. It is different with the remote past. Here the interests that are common to the aged person and to those around him are usually lacking. The memory defects of the aged for past events therefore remain relatively unnoticed. Finally, when there is opportunity to confirm the fact that an aged person has a memory defect for the remote past one is impressed much less emotionally than when one finds he is able to unfold in great detail some event from the remote past. That an aged person has the capacity to recall an event from his childhood is so astonishing that one is affected much more emotionally than when one finds that he has forgotten such an event.

Another source of error is that too much attention is usually given to the quality of the recollections of the remote past. Such recollections are altogether too frequently distorted. It is well known that an adult, say 30 years old, involuntarily distorts actual occurrences that he recalls from his early childhood. And why should not the aged do the same? So that what impresses one in the aged as a positive indication of a good memory may in actuality be only a mnemic distortion.

Furthermore, one is accustomed to observe usually only the spontaneous manifestations of a good memory and is apt to pay much less attention to the answers

obtained on asking definite questions. When a certain person narrates that thirty years ago he wore a certain suit of clothes, it is evident that he tells about something that he just happens to remember. Even if a man's memory were unusually bad he would still be able to tell what he recalls, but at the same time he would make little effort to recall other things, nor would he admit that he makes no effort to recall them. It is futile to attempt to evaluate a man's memory by his spontaneous utterances because, given two persons, one with a very good and the other with a very poor memory, neither of them will utter spontaneously anything except what he remembers. In order to evaluate correctly a man's memory it is essential that he answer a given series of questions or problems; no attention is to be paid to his spontaneous utterances. Weissfeld has no doubt that the formulation of Ribot's law has been based on observations made from spontaneous utterances of what the subject is able to recall.

Another frequent source of error arises from considering occurrences in the remote past as remote events, whereas actually such occurrences belong to the most recent past. Thus, an aged man will recall the date and entire situation of his first school visit, say sixty years before. He will also have a definite recollection of his teacher's appearance. On superficial examination this would seem to indicate that that particular man has a good memory for the remote past. This, however, is not so. While it is true that this event occurred sixty years ago, it is also true that as a psychic manifestation, as a memory content, this event has entered the man's consciousness innumerable times. He has thought and spoken about this particular occurrence several times; he might have thought about it continuously, or fourteen, or only two, days before. It is therefore not surprising that he can reproduce a series of events that he has experienced psychically only fourteen or two days ago. So that, here too, what impresses one as a good memory for the remote past may actually be a good memory for recent events. To evaluate correctly, therefore, memory for recent and for past events it is essential that one employ in the examination the same number of primary impressions and primary apperceptions, and that one is certain that there have occurred no repetitions of these impressions.

The aged are fond of talking volubly of their childhood. This is usually regarded as an indication of a good memory for the remote past. Mnemically, however, this is of little significance. Aged persons who are so fond of reminiscing about their childhood and adolescence usually also recite circumstantially and ceremoniously about most recent occurrences, as well as about many other things. This is the urge to sociability by lonesome persons and, in contrast, to people who seem to have forgotten completely their past, they are regarded as having a good memory for past events.

The author next discusses how far Ribot's law conforms to the actual facts as concerns poor memory for recent events. When persons with alleged memory defects for recent events are closely examined, it is found that it is not a question of memory at all; it is a question of poor apperception for new psychic impressions. Thus, a man is asked to repeat a series of numbers; being unable to do so, he is said to have a poor memory for recent impressions. In such cases, however, it must be borne in mind that when the impressions can be reproduced immediately, say within a few seconds, it is incorrect to speak of a good or of a bad memory. A patient who under such temporal conditions is unable to repeat a series of numbers has not a poor memory; he has a poor power of apperception. The numbers have made no impression on him, and he is therefore unable to reproduce them—there is nothing for him to remember. The disturbance here is not one of memory, but of apperception, not unlike that observed in the course of a disturbance of consciousness. Early in cerebral arteriosclerosis the patients usually complain that recently acquired knowledge, such as words of a foreign language, are completely forgotten. This, however, is not a question of "forgetting"; it indicates that the knowledge was never acquired. This is in complete accord with the well known fact that the cerebral arteriosclerotic person has no capacity for

adjusting himself to new situations—a defect which is also based on lack of apperception. Of course, defective memory is a characteristic manifestation of cerebral arteriosclerosis and is more marked for the remote than for the recent past. Thus, the very facts that, according to Ribot's law, are adduced as proof of its correctness are based on erroneous interpretation and confusion of memory and apperception. A clearcut differentiation between amnesic and apperceptive disturbances is not only of academic interest but of clinical significance in each case.

KESCHNER, New York.

CEREBRAL LOCALIZATIONS IN NEURO-OPHTHALMOLOGY: II. AUGUSTE TOURNAY, Rev. d'oto-neuro-opht. **10**:225 (April) 1932.

In this article, localizations in the occipital pole are considered. The area strictly reserved for visual receptions represents a perfect type of koniocortex. Here the horizontal stratification is accentuated; the third and fifth layers of cells are granular, and the fourth layer is divided into three: In the center is the ribbon of Vicq d'Azyr; above it lies the superior granular layer, and below is the deep granular layer. The ribbon of Vicq d'Azyr contains, among scattered grains, the stellate giant cells of Meynert, around which fibers of the optic radiations appear to terminate. This striated area (area striata of Brodmann) occupies a field divided by the calcarine fissure. The gyrus descendens of Ecker surrounds the forked extremity of the calcarine fissure. On the inner face of the occipital lobe, between the calcarine fissure and the parietal lobe and separated from it by the internal perpendicular fissure, is the cuneus; below the calcarine fissure is the lingual lobule. Thus the striated area of Brodmann begins at and below the junction of the perpendicular and calcarine fissures and extends backward, and widens and expands, first over the lingual lobule and then over the cuneus, and terminates on the posterior surface of the pole in the gyrus descendens of Ecker. It is striking to see how the anatomoclinical researches of Henschen coincide with architectonic principles and how the cortical areas, delimited by Henschen, cover exactly the territory marked, in fibers, by the ribbon of Vicq d'Azyr, and in cells, by Brodmann's striated area.

It is agreed that the cortical center of vision comprehends the calcarine fissure and the adjacent cortex. The superior quadrant of the retina is projected, via the superior bundle of the optic radiations, onto the upper lip of the calcarine fissure and the inferior part of the cuneus; the inferior quadrant, via the inferior bundle of the optic radiations, onto the lower lip of the fissure and the upper part of the lingual lobule. The question of the projection of the macula has been much discussed. Ordinarily, homonymous hemianopia does not exactly follow the vertical meridan of the visual field but spares the point of fixation, as though the two halves of the field overlapped. One explanation of this fact may be that each macula has a double innervation, one from each occipital pole. Morax postulated two small areas for the foveal center, one homolateral and the other contralateral, and situated at the posterior part of the striated area.

Surrounding the striated area of Brodmann, which coincides with the field for the reception of primary visual impressions, lies the parastriated area, and next to the latter is the peristriated area. Lying between these two areas is a narrow zone of giant pyramidal cells. Tournay supposes that this area is a center for immediate reflex actions, enabling the eyes to focus better and more rapidly. The pyramidal and giant cells in the adjacent territory may well cooperate in the more complex motor functions, such as movements of the eyes for orientation in space. Numerous islets of grains are found in the parastriated area and in the striated area, analogous to the arrrangement in the area along the posterior lip of the rolandic fissure for primary sensory impressions. It is then possible that for certain such primary sensory receptions, as well as for visual and auditory impressions, a primary correlation occurs in the neighboring islets.

With regard to the reception of light, form and color, Wilbrand supposed that each had a particular cortical localization. From observations made in cases

of hemianopia, however, it is believed that it is not so much a question of location as of degree of lesions. Lenz believed that certain lesions electively involved the cellular layers III and IVa and compromised perception of color. Krause attempted excitations of the visual area, which resulted in visions of flames, luminous balls and colored points—phenomena analogous to the elementary hallucinations observed in cases with lesions of the occipital pole.

Leaving the solid ground of primary visual areas, lesions that cause cortical blindness are found affecting the cortex. In other cases the visual recognition of objects is abolished—psychic blindness. In others, tactile agnosia exists. Bolton and Campbell distinguished a visuopsychic and a visuosensory area that corresponded to the striated, parastriated and peristriated areas. In these complex perceptions, correlation and association of the elementary receptions make the synthesis of perception and representation. The localizations are not strictly delimited.

In the area gyri angularis, lying in front of the peristriated area, is situated the center for symbolic recognition of written characters, the destruction of which results in verbal blindness. In right-handed persons this area is confined to the left side of the brain. Gratiolet has shown that the convolutions of the left hemisphere are developed before those of the right, and a clinical case of Tournay's gives support to this observation.

The central nervous system grows by the tremendous development of the connector elements. As a result of this, in the animal series, certain displacements occur. The enlargement of the surfaces between the primary areas of general sensibility above and in front, of audition below and of vision in the rear, and the development of the regions of psychic elaboration at the gyrus supramarginalis and gyrus angularis force the visual surfaces backward and behind the occipital pole.

Vision plays an important rôle in the motor integration involved in the behavior of the individual. The motor centers for movements of the eyes lie in the prerolandic area, at the foot of the second frontal convolution. Mott and Schaefer found in monkeys a middle zone for conjugate movements of the eyes laterally and a superior and an inferior zone for movements upward and downward, respectively. Vogt and Foerster verified these data in man. Sherrington showed that stimulation not only produced contraction of the agonists but also had an inhibitory effect on the antagonists. The intrinsic musculature is under the influence of another system: The sympathetic controls the dilator apparatus of the pupil, the parasympathetic, the contractor apparatus. Stimulation of areas other than the rolandic (the posterior temporal convolution and the convexity and internal surface of the occipital lobe) has been found to cause dilatation of the pupil and conjugate deviation of the head and eyes. Vogt and Bárány have shown that movements of the eyes provoked by stimulation of the area frontalis intermedia are made more quickly and smoothly than those provoked by stimulation of the occipital field, which may influence nystagmus from caloric stimulation of the labyrinth. While the cerebral cortex has a certain influence on nystagmus, experimental data have proved that the quick component of nystagmus appears to be controlled by the region of the vestibular nuclei. It may eventually be found that the auditory sphere initiates oculomotor reactions. DENNIS, Colorado Springs, Colo.

SPONGIONEUROBLASTOMA OF THE OPTIC NERVE IN NEUROFIBROMATOSIS (RECKLINGHAUSEN). ISADORE GOLDSTEIN and DAVID WEXLER, Arch. Ophth. **7**:259 (Feb.) 1932.

The literature is not lacking in reports of tumor formations in the optic nerve in neurofibromatosis. Many of these, however, are apparently not considered authentic. Verhoeff, while admitting that "the same influence which causes the supporting tissue of the peripheral nerve to proliferate in the form of a fibroma, may cause the supporting tissue of the optic nerve to proliferate in the form of a glioma,"

stated that not enough evidence had been adduced microscopically to support this theory, for the two conditions should have coexisted in the same patient in at least one instance. Earlier authors (Goldmann, Byers, Emanuel) held that tumors of the optic nerve were mesodermal in origin and considered most of these tumors to be fibromatous and probably related to neurofibromas. In spite of present knowledge that gliomas are glial, and therefore ectodermal, it is significant if a glioma-like tumor of the optic nerve can be demonstrated beyond question in a single case of generalized neurofibromatosis.

The case of a woman, aged 52, is reported. She was known to have had multiple peripheral neurofibromas for more than thirty years. Although careful examination of the eyes was not made, there were no external evidences of abnormality, and so far as could be ascertained there were no visual complaints. Only one examination of the fundus was made, and the results were reported as negative.

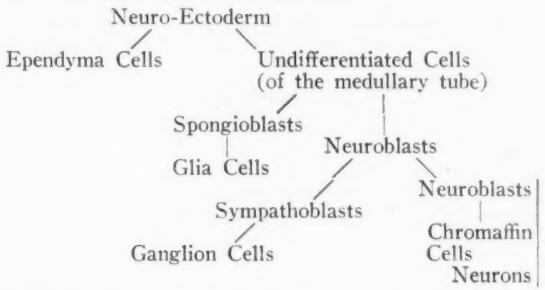
Both eyes were secured at autopsy. It was noted that the left optic nerve was uniformly thickened in the entire portion obtained and available for study; the greatest diameter of the cut section measured 6 mm. and that of the right nerve was 4 mm. The dura was thickened to twice the width of that in the right nerve, while the actual width within the pia was 4 mm. as compared with 3 mm. in the right. Five millimeters of each nerve was fixed separately for study in cross section.

Microscopically, two types of cells were distinguished in the main: 1. A large, pear-shaped cell with prominent, fairly large vesicular nucleus, and with a nucleolus. Most of the cells contained clumped masses scattered irregularly through the cytoplasm. Many bore processes, either short and stubby or long and fairly straight. For the most part such cells bore no processes and were oval or roughly quadrilateral, but their main characteristics as to body were similar to cells with processes. Whether these were of a separate type or merely the bodies of the monopolar cells in section could not be made out. A few bipolar cells of the same character were seen. Occasionally, a larger cell with two separate nuclei was found. 2. Smaller cells, with a large vesicular nucleus, containing threads of reddish-staining chromatin material. Others of this group were larger and oval, with irregular clumps in the cytoplasm, and more of a triangular blunt teatlike (dwarfed) process. Some were rod-shaped. All of these cells tended to occur in small groups and had few if any processes.

The ground substance in which all the cells were embedded was a loose, fibrillar syncytium. In sections stained with phosphotungstic acid hematoxylin, parallel groups of glia fibers, containing a few cells, were seen along the poorly staining septums. The latter stained feebly with eosin, and not at all with elastic tissue dyes. No apparent increase in the number of blood vessels over the normal was noted in the tumor. Neither vacuolization of the cells nor "cytoid bodies," as described by Verhoeff, were made out, and there was no tendency to hemorrhage or necrosis. The medullary sheaths stained normally in all portions of the nerve outside the tumor.

From this microscopic examination it is evident that the cells within this tumor were unlike those usually described for glioma of the optic nerve. There were no spindle cells, and while an occasional small cell could be classed as glia, the large nerve cells and those of the round and pyriform type appeared to require further differentiation. Verhoeff, after examination of tissue from this case, stated that although many of the large cells bore long processes causing a resemblance to ganglion cells, they did not contain Nissl bodies and showed numerous minute processes extending out into the surrounding tissue. He considered that these were merely large neuroglia cells. As a further evidence that tumors of the optic nerve should not be expected to contain ganglion cells, he offered the fact that the optic nerve never contains ependymal cells or remains of the embryonic neural canal, which form the basis for atypical gliomas of the brain, containing rosettes and, in some instances, ganglion cells. The stages of differentiation of various components of the primitive neuro-ectoderm into the mature cellular elements of

the central nervous system are represented by the outline of Globus and Strauss, which is illustrated in the accompanying diagram:



Clinically, the case reported is unique in that there was no defective vision or exophthalmos. Naturally, this was due in part to the confinement of the growth to the nerve. The author closes his report with a discussion relative to the common relationship, which undoubtedly exists, between gliomatosis and an allied disease, tuberous sclerosis. This close association has been insisted on by several authors who proposed an inclusive term, such as "gliomatosis or spongioblastomosis centralis, peripheralis or universalis," depending on the localization of the nerve structures involved.

SPAETH, Philadelphia.

HISTOPATHOLOGIC CHANGES IN CYSTICERCOSIS OF THE CENTRAL NERVOUS SYSTEM AND THEIR PATHOGENESIS. A. OPALSKI, Bull. Acad. polonaise d. sc. et d. lettres (classe de méd.), Oct.-Dec., 1931, p. 276.

The histopathologic changes produced by cysticercosis of the central nervous system are described on the basis of observations made by the author in twelve cases. The capsules surrounding the parasites were composed of an inner layer of epithelioid and giant cells, a middle layer of collagen fibers and scattered fibroblasts and an outer lamina of young connective tissue cells. These cells formed a loose network that contained many plasma cells and lymphocytes and smaller numbers of macrophages and polynuclear neutrophilic, eosinophilic and basophilic leukocytes. The middle layer was lacking in the capsules of intraventricular cysticerci. In the meninges the inflammatory phenomena were focal, becoming gradually less marked as the distance from the parasites increased. Occasionally, however, the involvement extended far down the spinal cord. When the number of cysticerci was unusually large, a more diffuse meningitis occurred. This did not differ essentially from other types of chronic meningitis. In the brain the inflammatory lesions were limited to the parasitic capsule, which was usually surrounded by a layer of neuroglia fibers. Degenerative changes were present in the nerve tissue near the cysticerci as well as in the cortex adjacent to the meningeal lesions. In these regions there were areas of complete or partial loss of nerve cells with compensatory proliferation of the neuroglia. In addition, small softenings were not uncommon. Ameboid changes and clasmatodendrosis were observed in the neighborhood of the parasites. The microglia exhibited little activity. Diffuse alterations of the brain did not occur in uncomplicated cases. Practically all cases showed hydrocephalus, regardless of the location of the parasites. Ependymal granulations and proliferation of the subependymal neuroglia cells were frequently encountered. In three cases patchy accumulations of epithelioid and giant cells were scattered over the ependyma. The subependymal vessels exhibited perivascular infiltrations in such regions. In two cases with parasites in the fourth ventricle, the lumen of the ventricle was obliterated by a massive proliferation of subependymal neuroglial elements. Vascular lesions were regularly found near the parasites. The commonest type of alteration was thickening of the adventitia, with plasma cells and lymphocytes in the adventitial spaces. Some vessels showed a combination of

periarteritis and endarteritis, which differed from Heubner's endarteritis in that endothelial proliferation and intimal infiltrations were lacking. Gummatous lesions were occasionally observed.

The pathologic changes owe their origin mainly to the following three factors: the pressure exerted by the parasites, circulatory disturbances secondary to the vascular lesions and toxic substances formed by the cysticercus. In the author's opinion the toxic factor is of great importance. Since the parasites usually adhere to one spot, it is assumed that the toxins are transported by the cerebrospinal fluid. Thus, the inflammation spreads from the meninges at the base of the brain, where the parasites lodge with greatest frequency, along the cysternal system to the spinal subarachnoid space. The process extends to the ventricles but does not involve the convexity unless parasites are located in that region. In cases showing only intraventricular cysticerci the changes are largely confined to the ventricles. The process spreads to the adjacent nerve tissue, but the neuroglial limiting membranes apparently prevent the toxins from penetrating deeply. The toxic and inflammatory phenomena are least marked in the cases in which only intracerebral parasites are found. The great increase of connective tissue in the meninges interferes with the free circulation of the cerebrospinal fluid. In most cases this is to be regarded as the chief cause of the hydrocephalus.

ROTHSCHILD, Foxborough, Mass.

THE MENINGEAL FIBROBLASTOMAS ON THE UNDER SURFACE OF THE TEMPORAL LOBE AND THEIR SURGICAL TREATMENT. CHARLES A. ELSBERG, Bull. Neurol. Inst., New York **2**:95 (March) 1932.

This article is one of a series of reports on the meningiomas and deals with the meningeal growths attached to the dura covering the floor of the middle cranial fossa. In the author's series, of the 102 meningeal fibroblastomas, 14.7 per cent lay on the under surface of the right or left temporal lobe. Most of the tumors were of firm consistency, well encapsulated and large, and the medial surfaces often extended near the midline, producing pressure on the cerebral peduncles or the pons. The importance of the position of the tumor in relation to the blood vessels from which it derives its vascular supply is emphasized and well illustrated by diagrams. In his clinical notes the author explains the mildness of subjective symptoms and objective findings even in the presence of a neoplasm of considerable size by the slow growth of the lesion and the ability of the surrounding brain to accommodate itself to slow changes in relations. He believes, however, that in some cases the clinical history, as well as the symptoms and signs, is so characteristic of a lesion in this region that accurate localization is possible. He gives as the most frequent sign of localizing value a slight or well marked weakness of the facial musculature on the side opposite that of the neoplasm. In some instances a type of facial weakness was observed that approached that seen in peripheral involvement of the seventh cranial nerve. This loss of power, which he calls "temporal," consists of a slight but definite weakness in the upper as well as the lower facial muscles. He believes that this type of facial weakness is also seen in other lesions of the temporal lobe and considers it of localizing significance. Convulsive seizures occurred in 12 of the 15 cases on which the study is based, and in 9 the convulsions were generalized. Disturbances of the visual fields were not as frequent as might be expected with lesions in this portion of the brain. Homonymous defects in the upper quadrants or complete homonymous hemianopia occurred in four patients. Visual hallucinations were reported in two cases. When the neoplasm was on the dominant side, disturbance of speech was unusual until the growth had attained a very large size. Disturbance of speech was more often preceded by slight mental disturbance and slowing of speech. Roentgen examination, frequently showing changes in the bones, in 9 of the 13 cases so studied were of value. In many cases, however, ventriculography was necessary. The author suggests the following as a syndrome of tumors in this situation.

"An adult, who gives no history of a trauma to the head or of a preceding intracranial disease, has had, for several years, attacks of unconsciousness or of generalized convulsions for which no adequate explanation has been found. After several years, the patient begins to suffer from attacks of headache and slight personality changes. When the patient is examined, few signs of localizing value are elicited. There is a papilledema or the discs are pale, and a questionable or slightly marked weakness of the muscles of one side of the face, supranuclear or "temporal" in type. The movements of the eyeballs are not disturbed excepting that on lateral gaze a true nystagmus, or nystagmoid movements of the eyeballs are observed. The nystagmus may be to both sides or only to the same side as that of the slight facial weakness. There are no signs of cerebellar disturbance and the vestibular tests fail to show any interference with the functions of the pathways. On roentgenological examination of the skull, there is found an atrophy of the sella which involves especially the floor and the posterior clinoid processes, and perhaps some increase in the convolutional markings as an evidence of increased intracranial pressure."

The article is concluded with a discussion of technical surgical procedures in which the desirability of excising the attached part of the dura by separation from the bone is emphasized.

KUBITSCHEK, St. Louis.

CHOREA GRAVIDARUM. PRENTISS WILLSON and ALEC PREECE, Arch. Int. Med. **49**:471 (March); 671 (April) 1932.

The historical and clinical data of over a thousand cases of chorea gravidarum are reported in tables covering forty pages. One of the cases was the authors', the remainder having been culled from the literature or obtained by questionnaires. The incidence is calculated as being about one in every three thousand pregnancies. The authors estimate that of every thousand patients with chorea, fifteen are pregnant. The average age was low, chorea gravidarum being essentially a disease of young women. It seems to be more frequent in unmarried mothers, as over 17 per cent of the pregnancies were illegitimate. The likelihood of recurrence during subsequent pregnancies is great, and a history of previous chorea (usually in childhood) was disclosed in 61 per cent of the cases. The authors state that 25 per cent of young girls who have St. Vitus' dance may expect to have a recurrence during pregnancy. These figures, however, are based on reports from the Baudelocque Clinic, which is a refuge for women with pathologic pregnancies in general. A third of the patients in this series gave a history of rheumatism, while almost half of them had previous or present heart disease. No cases of chorea gravidarum in Negresses were found. Only sixty-seven autopsy records were obtained; 87 per cent of these disclosed cardiac pathologic conditions. In the brain, pathologists have found intensive congestion, petechial hemorrhages, hyperplastic neuroglia and degenerative reactions generally, all changes reaching their maximum in the corpus striatum.

As a rule, chorea is a complication of early pregnancy, two thirds of the cases beginning in the first half of the gestation period. The average duration of fatal attacks was six weeks, and of attacks terminating in recovery, two and one-half months. Between pregnancies and during sleep choreiform movements generally terminate. In somewhat less than half the cases, pregnancy continued until term. The symptoms are those of ordinary Sydenham's chorea, with characteristic movements, usually generalized and frequently severe, with no fever in the ordinary case. When fever does appear it is of ominous significance. Urine, blood and blood pressure are not altered. There is no evidence, either laboratory or clinical, of toxemia of pregnancy. The mortality rate, taking the entire series as a whole, was 18 per cent, much lower than that commonly reported. Furthermore, there has been a steady improvement in this figure from 25 per cent in 1880 to 12 per cent in the last few years. Curiously enough the rate is lower in patients who have had more than a single attack of chorea gravidarum, being only 10 per cent in this group. The death rate is lower among the younger women in the group, but does not vary much with time of onset in reference to

the pregnancy. In cases in which labor was allowed to proceed without interruption, or in which abortion was spontaneous, the death rate was 13 per cent. In the group in which there was intervention the mortality was 33 per cent. The group in which there was spontaneous premature birth showed a death rate of 34 per cent. The fetal mortality was 51 per cent. Chorea of adults is more fatal than chorea of children generally, but it was three times as fatal to pregnant women as to adults as a class.

Treatment, the authors believe, should be conservative. They object vigorously to morphine or chloroform, and they consider that application of iodine to the cervix or administration of arsenic or salicylates orally is of no value. Sedatives may be used, such as chloral hydrate or the barbiturates, but they must be used cautiously. A rich, easily digested diet is required. If the regimen of rest, sedation, nourishment and seclusion fails to bring about improvement, if movements become violent or if speech becomes incoherent, the mind clouded or sleep impossible, labor should be induced. The paper is closed with a bibliography containing almost four hundred references. DAVIDSON, Newark, N. J.

THE EFFECTS OF INJURY UPON THE BRAIN. C. P. SYMONDS, Lancet **1**:823 (April 16) 1932.

The effects of direct injury to the brain fall naturally into two groups. One comprises cases which end fatally, usually within the first two or three days, with postmortem evidence of gross laceration and contusion. The second comprises all cases in which the patients survive the injury. The author discusses certain problems from the latter group of cases. "Traumatic stupor" is present in cases in which the mental state varies from profound stupor to a moderate clouding of consciousness, with phases of irritability, excitement and delirium. In the great majority of these cases signs of focal damage of the brain are conspicuously absent. It is striking that in relation to the severity of the mental disturbance in the earlier stages, recovery of cerebral function is remarkably rapid and complete. The essential cause of traumatic stupor most likely is direct injury of the nerve tissues with subsequent reactive changes; increased intracranial pressure and subarachnoid hemorrhage play a subordinate rôle.

In treatment, repeated lumbar puncture, controlled with manometric readings, should be performed. When the spinal fluid pressure is high, it should be reduced to a normal level by drainage. Supplementary treatment, such as the administration of concentrated magnesium sulphate solution by rectum or intravenous injections of hypertonic dextrose solution, may be given. The guiding principle, however, will be to provide optimum conditions for the natural recovery of damaged cerebral tissues in the early stages, and a carefully graduated and prolonged convalescence.

Another symptom complex is termed "the post-traumatic cerebral syndrome," the symptoms of which may be observed either in the convalescent stage after a severe injury with traumatic stupor or after a minor injury with or without concussion. Here, again, is found a clinical picture in which the signs of focal cerebral damage are lacking as a rule. The organic basis of this condition has been shown to comprise minor degrees of damage of the nerve cells and fibers, as well as changes in the pressure and circulation of the cerebrospinal fluid. Injury of the brain stem would appear to be not rare. Vertigo on quick movements of the head is one of the more distressing symptoms following this type of disturbance. Diplopia of the nuclear type is not uncommon. Headache is frequent; it may be distinguished as one of three types: The first is that complained of by the patient in terms of discomfort rather than of pain, a continuous sense of numbness or pressure, aggravated by all kinds of mental stimuli. A second variety, often associated with the first is equally frequent; the complaint is of a throbbing, piercing or aching, localized rather than diffuse, and occurring in bouts, usually of brief duration. The discomfort is aggravated by change of posture and by physical effort as well as by mental stimuli. A third and relatively

uncommon variety appears in bouts of considerable duration and severity and has a bursting quality, often associated with vomiting, thus suggesting a hydrocephalic state.

One other aspect of the clinical problem is given considerable emphasis. In a considerable number of cases, symptoms of cerebral injury may supervene after a more or less latent interval. The clinical course excludes late meningeal hemorrhage as the cause. Furthermore, it would seem to be more than a gradually developing reaction of the cerebral tissues to areas of necrosis produced by the initial injury, a process which has been termed traumatic encephalitis. The intensity of the symptoms in such a case, however, suggests that other factors also, probably hydrostatic, are active.

BECK, Buffalo.

SUPRASELLAR ANEURYSM. L. VAN BOGAERT, J. HELSMOORTEL and R. NYSSEN, Rev. d'oto-neuro-opht. **10**:325 (May) 1932.

A man, aged 37, who had had a fall from a motorcycle three years previously and was blind for the following three weeks, was suddenly stricken with amaurosis in the left eye on Aug. 17, 1931. This was followed in a week by blindness in the right eye. There was violent headache, and examination revealed a bilateral optic neuritis. A few days later an infundibular syndrome, with rise of temperature, appeared. Opening the sphenoidal sinus aggravated the condition; a state of mental confusion with marked agitation rapidly set in. Death from cachexia, with gangrene of the feet, occurred in six weeks. There were no clinical or biologic signs of syphilis.

Autopsy revealed an aneurysm, arising a little below the bifurcation of the anterior cerebral and the internal carotid arteries. Its largest diameter was in the prechiasmatic segment of the anterior cerebral artery. The tumor lay on the inferior surface of the anterior part of the brain, in front of the mammillary bodies; it covered the angle of the left optic tract with the chiasm and compressed the left olfactory bulb and chiasm, separating and grooving the orbital convolutions up to the level of the corpus callosum. The head of the caudate nucleus was infiltrated in its inferior segment; the beak of the corpus callosum was compressed and the ventricle obliterated. A thick meningeal exudate agglutinated the chiasm, stem, suprachiasmatic arterial circle and the orbital convolutions. Microscopically, no trace of endarteritis was found in the adjacent arteries. The veins in the vicinity were filled with old clots, and their middle tunics were infiltrated with macrophages loaded with hematic débris. A fresh meningo-encephalitis was seen at the orbital part of the gyrus rectus; it extended to the anterior part of the caudate nucleus, the innominate substance of Reichert, the anterior perforated space and the lateral regions of the third ventricle. A large number of the chiasmal fibers were destroyed. The oldest lesion was of the left optic nerve, which, with a part of the left tract, was surrounded with a thick meningeal exudate.

The ophthalmic picture most often seen in suprasellar aneurysm is blindness of one eye, with temporal hemianopia or a double atrophy. In the last instance, in the absence of the infundibular syndrome, the diagnosis is never made without a minute campimetric measurement. The presence of a central scotoma may lead to error, and sometimes there is a spontaneous return of vision that may be confusing. The infundibular syndrome in the case reported consisted of a transitory polydipsia and polyuria. But for the fact that the lack of arteritis in the vessels near the aneurysm spoke against a general arteritis, the gangrene and the aneurysm might have been attributed to the latter. The general symptoms were likewise few. Cushing stated that saccular aneurysm, in contrast to arteriovenous aneurysms, angiomatous malformations and vascular tumors, do not show a bruit on auscultation. The operation on the sphenoidal sinus probably modified the course of the aneurysm and forestalled its rupture, as there was considerable bleeding from it. The operation was rapidly followed by fever and increase of headache, caused by a localized meningo-encephalitis, as shown by the autopsy,

that had evidently begun some time previously. The etiologic diagnosis was probably an old traumatism, which caused contusion of the arterial walls, eventuating in the aneurysm.

DENNIS, Colorado Springs, Colo.

CONDITIONED REFLEXES AND HABIT FORMATION. W. HORSLEY GANTT, Brit. M. J. **1**:517 (March 19) 1932.

In this article the author shows the relationship between conditioned reflexes, habits and behavior, and illustrates his contention in a convincing manner. In habit, he says, there are a situation, a response and a reward, which may be either distant or immediate. The difficulty of determining conditioned from unconditioned reflexes is emphasized. The essentials for the production of conditioned reflexes are enumerated. First, there must be some emotional disturbancce (in employing the term "emotion" he indicates a fundamental subcortical excitation in the center in which it is desired to elaborate the conditioned reflex). The more intense the emotion, the stronger will be the resulting conditioned reflex and the quicker its elaboration. Repetition alone is not the mechanism of the formation of the conditioned reflex. The organism must be in a proper state; for example, a conditioned food reflex could not be established if the subject had been satiated. The number of repetitions varies with species, intelligence and age. In fish it may be necessary to repeat the laboratory stimulus three hundred times to form a conditioned reflex, in the dog from ten to fifty times, and in a child from four to ten times. Old animals elaborate conditioned reflexes slowly or not at all. An idiot may not form a conditioned reflex as quickly as a fish. Inhibition is then considered. External or indirect inhibition is illustrated as follows: A conditioned food stimulus is given, and the dog turns toward the place where the food is; if some one enters the room, his presence inhibits the food reflex and the dog turns away from the food toward the newcomer. Internal conditions may act similarly. For example, the tension of a full bladder or some irritating lesion in the mouth or on the body may diminish or inhibit all conditioned food reflexes. The other form of inhibition is direct and is a distinctive cortical phenomenon. It develops as a gradual process and does not reach a maximum until after some lapse of time. It has the property of becoming diffuse, spreading over the cortex, remaining a long time and then concentrating again. The simplest way to bring about this type of inhibition is by repetition of the conditioned stimulus and failure to support it by the unconditioned stimulus (giving food in the case of the food reflex). When the conditioned stimulus is thus applied a number of times without reenforcement, the flow of saliva gradually decreases with each repetition and finally drops to zero. The number of repetitions necessary for the extinction of this reflex varies with the animal, and with intelligence. Children are more plastic than dogs in that conditioned reflexes are elaborated quicker and disappear faster when they are not reenforced. The author then translates some of the teachings of William James into the language of conditioned reflexes and indicates that in his opinion the behavior of man can be viewed, from the standpoint of Pavlov, as a long chain of conditioned reflexes. He rightfully cautions against viewing results obtained with one conditioned reflex in one species as being applicable and comparable to conditioned reflexes of another species and being used as a measure of intelligence or capability.

FERGUSON, Niagara Falls.

ARTHRITIS OF THE CERVICAL SPINE: SOME NEUROLOGIC MANIFESTATIONS. J. D. BISGARD, J. A. M. A. **98**:1961 (June 4) 1932.

The results of an analysis of symptoms in sixty cases of arthritis of the cervical spine are given. Thirty-one patients complained of headaches either alone or associated with other symptoms. The headaches were occipital or suboccipital in location with, in some cases, radiation into the neck or up over the head. In many cases they became worse in damp and cold weather and were aggravated by bending or twisting the head and by jarring in walking, coughing or sneezing.

Frequently relief was obtained by supporting the head with the hands, by lying down, or by the application of heat. Eight patients complained of "neuritis" in the shoulders and arms. The pain was usually described as quite severe, often dull and usually paroxysmal, but occasionally constant. Except in one case with a typical ulnar nerve distribution the pain did not have a definite segmental arrangement and in most instances was not well defined. In five cases it was unilateral; in three, bilateral. Its extension varied from the shoulder to the tips of the fingers. Frequently there was an associated sense of weakness and awkwardness in motion of the fingers and arms and, in most cases, numbness and paresthesia. Sensory disturbances were prominent features in five cases and were noted in four additional cases. The topography of these sensations and the areas of diminished sensations were usually diffuse and in only two instances sufficiently well defined to correspond to distribution in the nerve root or along the nerve trunk. These two cases presented objective evidence of involvement of the sensory nerves capable of localization in the nerve roots. The patients stated that their arms or hands felt as though they were asleep, or they complained of tingling (pins and needles), burning, crawling (of bugs) and stinging sensations. Of the sixty cases, there were four with definite evidence of motor nerve involvement and a large group in which some disturbance could be assumed. Associated with the sensory symptoms in the majority of cases was a complaint of weakness or difficulty in coordination of certain muscle groups or of the entire extremity. Objective confirmations of these observations were not infrequent. Definite atrophy, generalized or localized to certain muscles, was noted in several cases, but obviously this is difficult to differentiate from atrophy of disuse resulting from the pain. Wasting of the thenar and hypothenar eminences was observed in several cases. Ten illustrative case histories emphasize the complete or relative silence of subjective and objective evidence of the primary lesions of vertebral arthritis as compared to the major rôles played by the nerve roots which are secondarily involved. In general, it may be said that arthritis of the cervical spine manifests itself by signs and symptoms remote in respect to the spine. Radiculitis may involve any group of nerve fibers contained in a nerve root; that is, somatic and sympathetic, motor and sensory, and the symptoms may reflect evidence of irritation or complete or partial loss of function. The symptoms are frequently elusive and may simulate many visceral, cerebrospinal, local and general disease entities.

EDITOR'S ABSTRACT.

NONSUPPURATIVE OTOGENOUS TEMPORAL ENCEPHALITIS, WITH PARALYSIS OF THE GAZE UPWARD. H. ROGER, A. CRÉMIEUX and BONNET, Rev. d'oto-neuro-opht. **10**:332 (May) 1932.

Aside from the ordinary abscess of the brain, otitis may be complicated by various types of cerebral accidents, notably nonsuppurative encephalitis. A man, aged 22, came to the hospital complaining of a severe headache in the left temporoparietal region, which was worse at night and became paroxysmal at times. He had also disturbed vision, vertigo, occasional projectile vomiting, lassitude, anorexia, constipation, emaciation and a tendency to somnolence. Pott's disease had occurred in childhood. A chronic otorrhea in the left ear was complicated by mastoiditis in 1930 and operation was performed, which resulted in a dry ear. The patient was stuporous but responded well to questions. The patellar reflexes were normal, the achilles reflex was more lively on the left, and the plantar reflexes were absent. In the finger-to-nose test a slight dysmetria, quickly corrected, was noted on the left side; sensibility to touch and pricking was better on the left arm, and there was a slight hypesthesia of the right forearm. The left pupil was irregular and larger than the right; associated movements of raising the globes were abolished, and there was nystagmus when the patient looked laterally. A facial paresis existed on the right, and the uvula deviated to the right. The other systems were normal. The temperature varied from 37 to 37.9 C. (98.6 to 100.2 F.); there were mild leukocytosis and papillary stasis. A roentgenogram showed destruction of the sella turcica and widening of the sutures.

An exploratory operation was performed on the left mastoid (which was found in order); a trephine opening in the temporal region revealed congestion and tension of the meninges. Several needle punctures of the brain did not result in the location of pus. A tear in the dura necessitated its incision, which was followed by hernia. The wound was left open. During the following six days the hernia increased, then it began to diminish, and healing was rapid. All symptoms, including the ocular paralysis but excepting the facial paralysis, soon disappeared. On two occasions since discharge the patient has suffered a convulsive crisis which consisted of unconsciousness and convulsive movements of the left arm and leg and the left side of the face; there was no involuntary micturition or biting of the tongue, but there was amnesia on waking. Otherwise the local and general condition is excellent.

The intracranial complication appeared more than eighteen months after the mastoid exenteration. It represented possibly a presuppurative stage of the infection. An exceptional symptom was paralysis of the third nerve; it was probably a localizing sign and was caused by collateral edema. Might not this sign and the fever, not accompanied by slowing of the pulse, be indicative of nonsuppurative encephalitis? The ultimate prognosis must be reserved, in spite of the prompt recovery.

DENNIS, Colorado Springs, Colo.

THERAPEUTIC ACTION OF CEREBRAL LIPOIDS IN DEMENTIA PARALYTICA. CHOROSCHKO, CALENKO, PETROWA and POWOLOTZKAJA, Sovet. Klin. **15**:270, 1931.

Choroschko and his collaborators maintain that progressive paralysis is not identical with cerebral syphilis. The clinical aspects, the pathologico-anatomic aspects and the response to treatment show a difference between the two forms. However, statistics, the Bordet-Wassermann reaction or the search for, and detection of, spirochetes cannot decide this question. The author considers dementia paralytica as a metabolic disturbance that involves the entire organism and in which the cell toxins play a certain part. Considered from this point of view, all attempts to influence the organism of patients with dementia paralytica by means of nonspecific therapy gain special interest. The author describes observations made in one year on fifty patients with dementia paralytica, on eleven patients with the tabetic form of dementia paralytica and on twelve patients whose disorder had been diagnosed as "cerebral syphilis." According to the severity of the disturbance, the patients are divided into three groups. In regard to the results of the treatment, it is stated that the designation "considerable improvement" is applied to the patients who regained their working capacity (twenty-three of fifty patients with dementia paralytica), and merely "improvement" to the patients who showed physical and psychic improvement, but who did not regain their working capacity (twenty of fifty patients with dementia paralytica); in five of these fifty patients no change was noticed, and in two an exacerbation set in (not under the influence of the preparation but as a result of the course of the disease). In all three groups into which the patients had been divided according to the severity of the disease, there were patients in whom the treatment effected "considerable improvement." However, in the group of the severest cases the results were less favorable. In three patients with hereditary late syphilis of the central nervous system there was no improvement. In the tabetic form of dementia paralytica, the results were generally poorer than in dementia paralytica. In cerebral syphilis the results were generally the same as in dementia paralytica but somewhat less favorable. The cerebral lipoids were administered intramuscularly in daily quantities of 2 cc. The treatment was usually continued for from forty to sixty days. Cerebral lipoids were well tolerated by the patients and produced no fever. Other therapeutic measures were not taken. The cerebral lipoids that are introduced into the organism probably fill the gaps that result from the disintegration of the lipoids caused by the disease process; moreover, by producing an advantageous reaction in the organism they increase the vital energy and the vital capacity of the cells. The author considers the treatment worthy of further attention.

EDITOR'S ABSTRACT.

THIRTY YEARS OF PSYCHIATRY. HOWARD W. POTTER, Ment. Hyg. **16**:4 (Jan.) 1932.

In the twentieth century, psychiatry has for the first time become a therapeutic as well as a diagnostic science. To Freud is given the credit for shifting the emphasis from description to understanding. The scope of the specialty has widened so that psychiatrists study and treat not only those with mental diseases, but also neurotic persons, criminals, industrial delinquents and problem children and adults in general. The freudian concepts in one form or another permeate psychotherapy, and in almost every form of psychiatric treatment some psychoanalytic principle is involved. This extensive application of the freudian point of view is not at all incompatible with an organic approach. A second significant contribution of the twentieth century is the standardization of intelligence tests from the form first introduced by Binet and Simon in 1905 to the time-tried American revision presented by Terman in 1916. Potter also attaches importance to the genetic contributions of Goddard and Davenport, although he admits that knowledge of the transmission of mental defects and disease is seriously incomplete. Another recent advance is the growing stress placed on constitutional factors in maladjustment, as exemplified by the work of Kretschmer and others. Closely related to this is the progress made in the endocrinologic and metabolic aspects of psychopathology, including the promising work of Loevenhart and Lorenz on carbon dioxide narcosis and the recent contributions of Bleckwenn. Of major importance is the increasing intimacy between psychiatry and general medicine as evidenced by the tendency of the internist and the surgeon to turn to the psychiatrist for assistance in a psychologic understanding of medical problems, as well as by the elevation of neuropsychiatry in the curriculum of the medical school. Potter cites one instance in which a medical school has increased the time allotted to psychiatry from ten to one hundred and twenty-five hours in the last three years. Assignment of focal infection as a factor in the production of psychoses has been, perhaps, exaggerated, but it has served to call attention to a field that well deserves further attention and research. One of the most dramatic advances has been the discovery of the cause, and the development of a treatment, for dementia paralytica. Noguchi and Moore first demonstrated spirochetes in the brains of persons with dementia paralytica in 1913; Wagner von Jauregg performed his first inoculation with malaria in 1917, and Jacobs and Heideberger announced the discovery of tryparsamide in 1918.

From this review of psychiatric progress in the last thirty years, one is led to conclude that by far the greater part of present-day methods of understanding and treating the mentally ill has been the contribution of the twentieth century.

DAVIDSON, Newark, N. J.

THE EQUILIBRIUM BETWEEN CEREBROSPINAL FLUID AND BLOOD PLASMA: III. THE DISTRIBUTION OF CALCIUM AND PHOSPHORUS BETWEEN CEREBROSPINAL FLUID AND BLOOD SERUM. H. H. MERRITT and W. BAUER, J. Biol. Chem. **90**:215 (Jan.) 1931.

The method of Fiske and Logan for the determination of calcium and the method of Fiske and Subbarow for the determination of phosphorus were used in this investigation. The authors summarize their results as follows: 1. The normal serum calcium content was found to vary between 9.35 and 10.6 mg. per hundred cubic centimeters, with an average of 10 mg. The cerebrospinal fluid calcium ranged from 4.5 to 5.23 mg. per hundred cubic centimeters, with an average of 5 mg. The ratio of the cerebrospinal fluid calcium to the serum calcium varied from 45 to 53 per cent, with an average of 50 per cent. 2. The serum and cerebrospinal fluid calcium content was found to vary directly with the serum protein in such a way that there was no significant change in the ratio of cerebrospinal fluid calcium to serum calcium with changes in the serum protein. 3. The serum and

cerebrospinal fluid calcium content was normal in various nonsuppurative diseases of the central nervous system. 4. In meningitis there was a slight diminution of serum calcium content, with an increase in the cerebrospinal fluid calcium content. This increase in the cerebrospinal fluid calcium content can probably be accounted for by increased permeability of the meninges and the choroid plexus, and the resulting increased protein in the cerebrospinal fluid. 5. There was a slight decrease in the serum and the cerebrospinal fluid calcium content in pulmonary tuberculosis. 6. The drinking of water during the antidiuretic action of vasopressin caused a decrease in the serum and cerebrospinal fluid calcium. 7. There was a definite decrease in serum calcium content at the end of pregnancy. The amniotic fluid calcium content was found to vary between 5.4 and 8.8 mg. per hundred cubic centimeters, with an average of 6.59 mg. 8. The calcium content of the diet had a slight influence on the level of the serum calcium of cats. 9. In cats the cerebrospinal fluid calcium content averaged 54 per cent of the serum calcium, and the aqueous humor calcium content averaged 60 per cent of the serum calcium. 10. In nonsuppurative disease of the central nervous system, the cerebrospinal fluid phosphorus content was found to vary between 31 and 45 per cent of the serum phosphorus, with an average of 38 per cent. In suppurative disease of the nervous system, the ratio of cerebrospinal fluid phosphorus to serum phosphorus varied between 35 and 123 per cent, with an average of 40 per cent.

DAILEY, Boston.

STUDIES ON THE DIENCEPHALON OF CARNIVORA: III. CERTAIN MYELINATED FIBER CONNECTIONS OF THE DIENCEPHALON OF THE DOG (CANIS FAMILIARIS), CAT (FELIS DOMESTICA), AND AEVISA (CROSSARCHUS OBSCURUS). DAVID MCK. RIOCH, J. Comp. Neurol. **53**:319 (Oct.) 1931.

This article gives an account of the fiber connections of the thalamus and hypothalamus of three carnivora, as seen in serial sections stained by the Weigert-Pal method and counterstained with carmine, at the Central Institute for Brain Research, Amsterdam, Holland. The material is described under thirteen headings. There are fourteen illustrations, in which are shown 196 structures. The carnivora stand midway between rodents and primates in the increase of the importance of the cortical connections of the thalamic nuclei, and in the differentiation between the cortical and striatal paths. The mammillothalamic tract consists, in the cat, of a single bundle, but in the aevisa (a small African carnivore) of three fascicles, and in the dog of four. The anterior group of thalamic nuclei are similar in pattern in the three forms, and their main fiber connections correspond with that of other forms already described in the literature. The medial group of nuclei are also similar, but their connections are not so plain, and investigators of other forms present conflicting evidence. The morphology of the lateral group of nuclei is similar. The pulvinar nuclei is best differentiated in the dog. The author suggests that the lateral nuclei may act as association centers between the neopallium and basal vegetative centers. The larger, lateral division of the medial lemniscus enters the caudal pole of the nucleus ventralis. The ventral nucleus is thus the main end-station for the large ascending sensory systems, including the dentatorubrothalamic tract. The epithalamus shows less variation between the dog, cat and aevisa than does any other diencephalic system. The author recognizes four main components in the stria medullaris. The morphology of the lateral geniculate nuclei shows significant differences in the three forms. The dorsal portion of the nucleus is relatively largest in the dog, and shows distinct lamination. It is smallest in the aevisa and intermediate in the cat. The ventral portion, on the other hand, is largest in the aevisa, and its fiber connections are distinct. It is smallest in the dog and intermediate in the cat. The morphology of the medial geniculate nuclei is the same in the three forms, and this is true also of the general configuration of the hypothalamic area.

ADDISON, Philadelphia.

"Abortive" Poliomyelitis. J. R. Paul, R. Salinger and J. D. Trask, J. A. M. A. **98**:2262 (June 25) 1932.

An epidemiologic study of poliomyelitis was made, in which particular emphasis was laid on the problem of so-called abortive poliomyelitis, in an effort to define this entity, to determine its relative frequency and to uncover methods whereby it can be recognized. Common usage of the term abortive poliomyelitis has proved so ambiguous that in order to define the issues in this disease the authors employ the term characteristic minor illness in association with poliomyelitis, so that ground may be cleared for a critical, definitive study. The symptomatology of some of these minor illnesses is more or less characteristic but not specific, being essentially that of an acute infection of short duration. Such symptoms as fever, sore throat, headache and vomiting dominate the clinical picture. In a survey of 222 families in each of which one or more cases of poliomyelitis had occurred it was found that, coincidentally with the onset of the known case or cases of poliomyelitis, characteristic minor illnesses developed with a high degree of frequency in the other children of susceptible age. Thus in the age group 1 to 4 years, 39 per cent of children with familial exposure developed a minor illness, and in the age group of 5 to 9, this incidence was 32 per cent. In sixty control families comparable data were obtained, showing that while the epidemic prevailed, the incidence of similar minor illnesses was about 9 per cent among local children under 10, who had not been exposed to a familial case of poliomyelitis. In a survey of three communities the ratio of cases of poliomyelitis to these characteristic minor illnesses was the same in each; namely, 1:6. Experiments were made in which the poliomyelitic virus was isolated from nasopharyngeal washings in two examples of these minor illnesses. Negative results were obtained in ten others. In both the successful experiments of virus isolation, the nasopharyngeal washings were obtained on either the first or the second day of the disease; three other attempts to isolate the virus during this period proved negative. Strong evidence is brought to bear that these minor illnesses, which are evidently more frequent than has hitherto been suspected, have a common causal relationship with orthodox poliomyelitis. The authors believe that the question as to whether the term abortive poliomyelitis may be justifiably ascribed to these illnesses would seem to be one of definition.

Editor's Abstract.

The Equilibrium Between Cerebrospinal Fluid and Blood Plasma. IV. The Calcium Content of Serum, Cerebrospinal Fluid, and Aqueous Humor at Different Levels of Parathyroid Activity. H. H. Merritt and W. Bauer, J. Biol. Chem. **90**:233 (Jan.) 1931.

The authors summarize the results of their investigations as follows: The constancy of the serum calcium level needs no comment. The constancy of the cerebrospinal fluid calcium level is more remarkable. The serum calcium varies with serum proteins, low serum proteins being regularly associated with low serum calcium. The variations in serum calcium which accompany changes in parathyroid activity are, however, independent of the serum protein level. It is interesting, therefore, to compare the effect on the cerebrospinal fluid calcium level of these two apparently different types of variation in the serum calcium. The outstanding result in both cases is that the cerebrospinal fluid calcium remains remarkably constant in spite of well marked changes in the serum calcium level. The striking lowering of the serum calcium occurring in parathyroid tetany and the sustained elevation of the serum calcium following the administration of parathormone were without appreciable effect on the cerebrospinal fluid calcium level. Variations in serum calcium associated with different levels of serum protein were reflected to a slight degree in the cerebrospinal fluid. The data, however, were not sufficient to bring out their relationship clearly. The greatest variation in the cerebrospinal fluid calcium was observed in patients who took water by mouth during the antidiuretic action of pitressin. In these cases there was noted a dilution of both the blood serum and the cerebrospinal fluid.

If the cerebrospinal fluid is accepted as a dialysate in osmotic and hydrostatic equilibrium with the blood plasma, the data indicate that variations in serum calcium occurring during parathyroid tetany or following the administration of parathyroid extract are chiefly and perhaps wholly limited to the nondiffusible calcium. The data suggest also that those variations in serum calcium which are associated with different levels of serum protein involve both the diffusible and the nondiffusible calcium.

DAILEY, Boston.

THE FOREBRAIN OF THE OPOSSUM, DIDELPHIS VIRGINIANA; HISTOLOGY. Y. T. LOO, J. Comp. Neurol. **52**:1 (Feb.) 1931.

The first part of this study, appearing in the *Journal of Comparative Neurology,* vol. 51, discussed the anatomy, and both parts should be consulted together to appreciate the scope of the subject. Three series of sections cut in different planes have been studied with Weigert, Nissl and Cajal technics. Some Golgi preparations were also used. In these 148 pages with 71 figures the cell masses and their fiber connections have been extensively described. The septal and paracommissural nuclei, tuberculum olfactorium, lamina terminalis, area preoptica and the strio-amygdaloid complex are analyzed. The arrangement of the cell masses and fiber tracts are similar in principle to that of man, with more sharp definition and less complication of detail. The cell masses are mainly laminated or aggregated. Most of the subcortical parts of the hemisphere appear to be more or less directly connected with the large olfactory apparatus, as is about half of the cerebral cortex. The claustrum seems to serve three functions, with the first predominant in this animal: (1) correlation between neopallium and paleopallium; (2) fore-and-aft correlation within the pyriform lobe; (3) fore-and-aft correlation within the ventrolateral neopallial areas.

The cerebral cortex shows neopallium (somatic cortex), archipallium (hippocampal formation) and paleopallium (piriform cortex), each with its own characteristic lamination pattern and its own system of projection fibers. The forebrain as a whole receives afferent fibers from three sources: olfactory from the olfactory bulb, visceral from the hypothalamus and somatic from the thalamus. The efferent fibers of the somatic system go from the neopallium through the lateral forebrain bundle; those of the cortical and subcortical olfactory and visceral regions go through the medial forebrain bundle. With this description of the opossum brain, further studies on the cerebral physiology and experimental morphology will be possible.

ADDISON, Philadelphia.

LEUCOCYTOSIS IN GENERAL PARALYSIS TREATED BY RADIOTHERAPY. L. E. HINSIE and J. R. BLALOCK, Psychiatric Quart. **5**: 432 (July) 1931.

Observations of the changes in total white blood cell counts and differential leukocyte counts were made on patients with dementia paralytica treated with fever induced by radiothermy. The apparatus is constructed on the same principle as a short wave radio transmitter with the exception that the energy is concentrated between two condenser plates instead of being directed from an aerial. The patient lies between the plates, and his temperature may be elevated to any desired height. The effort was made to reproduce the temperature curves as they occur in patients with dementia paralytica treated by inoculation of malaria. The effort was successful. A total of 204 white blood counts and 152 differential leukocytic counts were made on nine patients. Invariably leukocytosis was found associated with the period of elevation of temperature. The rise was about 6,500 cells per cubic millimeter. The increase was gradual, starting during the first hour of treatment and reaching a maximum about eight hours later. The average increase was generally 70 per cent above the control count, and a 50 per cent increase was maintained for about eight hours; a normal value was reached about twenty hours after the start of the treatment. After the patient was subjected to the current for from one to one and one-half hours, the temperature rose to from

104 to 105 F. The machine was then turned off, the patient was placed in a warm bed, wrapped in four or five blankets, and a few hot water bottles were applied. After about seven hours the blankets were removed and the temperature receded to normal in about three hours. The increase in leukocytes was confined almost exclusively to the polymorphonuclear neutrophils, a rise of about 12 per cent. This was accomplished at the expense of the lymphocytes, which decreased about 9 per cent, and, to a lesser degree, of the large mononuclear and transitional leukocytes.

HOWARD, Milwaukee.

MENTAL DISEASES OCCURRING IN FAMILY GROUPS. H. GOLDBLADT and A. ZIPES, Arch. f. Psychiat. **93**:423, 1931.

The authors present a study of mental diseases occurring in closely related members of family groups. The studies were undertaken in sixty-seven cases (thirty-four male and thirty-three female), the patients being members of thirty families. Ten of the patients were studied personally by the authors, whereas the others were studied from the hospital records of patients admitted between 1909 and 1924. The results of the study were: There were four examples of psychosis in mother and daughter, three in mother and son, one in father and daughter, five in brothers, three in sisters, twelve in brother and sister, one in mother, daughter and two sons and one in uncle and nephew.

Of the thirty family groups, twenty-five showed the same type of psychosis in the members of the same family, the psychoses being: schizophrenia, 17; manic-depressive psychoses, 3; hysterical psychosis, 1; feeblemindedness, 2, and dementia paralytica, 2. The authors found, however, that, although the disease entities were thus shown to be fairly frequently the same in different members of a given family, the actual disease picture differed markedly. This showed itself to such an extent that there was practically no case in which the clinical picture actually coincided in two or more members of the same family. There was a tendency toward anteposition of the psychosis in parents as compared with the children, and in older siblings as compared with younger. A study of other members of these families showed marked hereditary tainting of psychopathic type in all of the families.

The authors believe that the reasons for the difference in the clinical pictures of mental diseases in members of the same family are to be looked for in the environmental factors of the different cases.

MALAMUD, Iowa City.

PARENTAL ATTITUDES AND MENTAL HYGIENE STANDARDS. RALPH M. STOGDILL, Ment. Hyg. **15**:813 (Oct.) 1931.

In order to compare parental standards of child behavior with the outlook of mental hygienists on the same subjects, Stogdill prepared a list of seventy items of behavior and submitted it to a large group of parents. They were told to indicate the gravity or desirability of each by a number on a scale, the rating 1 indicating "of no consequence," the number 5 meaning "undesirable" and the symbol 10 meaning "very serious." Intermediate ratings were indicated by intervening numbers. A similar questionnaire was submitted to a group of mental hygienists. The items rated most serious by the parents were: stealing, masturbation, lying, cheating and disobedience, in the order given. Mental hygienists, on the other hand, considered depression, fears, cruelty, whining and suspicion the most undesirable traits. Among the qualities assessed by the parents as being of little or no consequence were: shyness, imaginative story-telling, bashfulness, make-believe daydreaming and excessive reading. Significant items on which these groups differed widely were: modesty, suspicion, bashfulness, seclusiveness, sulkiness and sensitiveness—all of which were much more serious to psychiatrists than to the parents. On the other hand, swearing, defiance, smoking, masturbation and engaging in obscene talk were taken much

more seriously by the fathers and mothers than by the mental hygienists. It would appear that parents regard transgressions against morality, opposition to parental control, disrupting the routine of the household and breaches of etiquette serious items of child misbehavior, whereas mental hygienists are inclined to emphasize introverted reactions and seclusive attitudes. Since child guidance should be primarily, or at least, ideally, a parental function, the fathers and mothers must be educated to more sound standards of psychically hygienic behavior.

DAVIDSON, Newark, N. J.

ENDEMIC PURPURIC MENINGOCOCCUS BACTEREMIA IN EARLY LIFE. STAFFORD McLEAN and JOHN CAFFEY, Am. J. Dis. Child. **42**:1053 (Nov.) 1931.

This careful report demonstrates the value of smears from purpuric lesions as an aid in the early diagnosis of meningococcus bacteremia. The authors report results of studies in 32 cases in a group of 233 cases of general types of meningococcus infections which showed these lesions. The technic of the examination is simple and can be easily and satisfactorily carried out in general practice. Their report shows that they were able to demonstrate the meningococcus in 83 per cent of the cases in which purpura developed. They noted that the blood culture gave negative results in each instance in which the purpuric smear gave negative results, and that the smears from the purpuric lesions always gave positive results when meningococci were present in the blood culture. In many cases this procedure demonstrated the bacteremic phase of the disease prior to the meningeal invasion, as noted by the lack of changes in the cerebrospinal fluid indicative of inflammation. Of the total number of cases studied it was shown that purpuric eruptions developed in 11 per cent and that when these eruptions were present the progress of the disease was much more explosive than in the ordinary typical case.

This diagnostic procedure, when the results were positive, was of importance in indicating the need for serum therapy prior to the development of real meningeal symptoms. It was interesting to note that of the sixteen patients who recovered, twelve received intravenous as well as intraspinous serum therapy. In the tabulation of the end-results of the therapy they reported that all patients in the first six months of life died, but in children more than 6 months of age the mortality was only 50 per cent.

This procedure should aid in establishing an early diagnosis in meningococcus meningitis at a time when serum therapy as a curative measure should be of the greatest value.

LEAVITT, Philadelphia.

THE INFLUENCE OF MALARIAL TREATMENT ON THE SEROLOGY IN DEMENTIA PARALYTICA AND THE PERMEABILITY OF THE CEREBROSPINAL FLUID-BLOOD BARRIER. F. VON ROHDEN, L. ZIEGELROTH and H. WALTER, Arch. f. Psychiat. **95**:127 (Aug.) 1931.

The authors studied the relationships existing between the outcome of malarial treatment and the changes in the serologic observations on 437 patients. The conclusions reached were: 1. Single reactions are not reliable for diagnostic or prognostic purposes. It is only the combined syndrome of a number of serologic tests that is of value. 2. Globulin reactions and the Wassermann reaction of the cerebrospinal fluid seem to be the best indicators in untreated dementia paralytica. In these cases the Wassermann reaction of the blood, the cell count and the permeability are not so valuable. 3. With the fever therapies it is important to consider the time factor. Provided that is done, it is found that the cell count and the permeability are the earliest to respond, whereas the Pandy reaction seems to be the latest. During the first year following malarial treatment, the authors found that the Wassermann reaction of the spinal fluid was affected more easily than that of the blood. In the second year this was reversed. The authors found certain relationships between permeability and other serologic tests but not in any relation to the clinical findings. 4. The blood-cerebrospinal fluid barrier, as well as the cell count, is much affected by changes in the disease process of

dementia paralytica. 5. It is of importance to consider an analysis of a number of repeated tests rather than the cross-analysis of the findings at any given time. 6. Serologic and clinical improvements do not necessarily go hand in hand, but they seem to correlate much better the longer the interval following the treatment. If the serologic reactions remain positive for more than two or three years following the treatment the prognosis is poor, and vice versa.

MALAMUD, Iowa City.

ON THE WEIGHTS OF THE PARTS OF THE BRAIN AND ON THE PERCENTAGE OF WATER IN THEM ACCORDING TO BRAIN WEIGHT AND TO AGE, IN ALBINO AND IN WILD NORWAY RATS. HENRY H. DONALDSON and SHINKISHI HATAI, J. Comp. Neurol. **53**:263, (Oct.) 1931.

Forebrain, stem, cerebellum and olfactory bulbs from 250 male and 213 female albino rats, and from 53 male and 71 female wild Norway rats were studied for their absolute weight, weight relations and percentages of contained water. The albino rats ranged in age from birth to 533 days. Each part was put into a separate weighing bottle, and a fresh weight determined. They were then dried in an oven at 98 C. to a constant weight. The increase in weight of the parts of the albino brain on brain weight between birth and 533 days has the ratio in the cerebellum of 17:1, in the forebrain of 8:6, in the olfactory bulbs of 7:8 and in the stem of 5:4. There is no sex difference. The percentage of water in the parts increases rapidly from four to eight days after birth. The parts least developed at birth show the greatest increase in water during the first four days. Apparently, in order to undergo development, each part of the brain must attain about 88 per cent of water. In all cases the percentage of water decreases after the eighth day. The greatest loss is in the stem; the least, in the olfactory bulbs. The loss of water is determined mainly by the formation of myelin. The percentage of water in the female is slightly higher in all parts. When the age of the brain in the wild Norway rat is computed, it is found that the corresponding observed percentages of water are in agreement with those of the albino rats at like ages.

ADDISON, Philadelphia.

ENCEPHALITIC SEQUELAE AND THEIR TREATMENT. SAMUEL SMITH COTTRELL, Am. J. Psychiat. **11**:253 (Sept.) 1931.

Stramonium, Cottrell believes, is the best drug available for the treatment of postencephalitic parkinsonism. He reports results in the treatment of twelve patients, all with rigidity, tremors and drooling. Many laboratory tests were performed, but no constant deviation from the normal was found, except in basal metabolic readings, in which considerable day by day variation was found for each patient. The therapeutic program applied to his patients consisted of a diet low in protein and highly nourishing, with an excess of fluid, supervised exercise and rest periods, and administration of stramonium. A pill was used containing 2.5 grains (0.16 Gm.) of stramonium, which is equivalent to 25 minims of the tincture. The dosage was 1 pill three times a day during the first week; 2 pills after meals in the second, and 3 pills three times a day in the third and all subsequent weeks. If tremor did not subside by the fourth week, scopolamine, $\frac{1}{150}$ grain (0.00043 Gm.), was given after each meal and the dose of stramonium was reduced to 3 pills daily. In no case were there any toxic symptoms, or any evidence of cumulative ill effect. All patients improved under this regimen; many who were helpless when they entered the hospital were able to take care of themselves within a month after the initiation of treatment. Rigidity was the first symptom to disappear, and reduction in tremor and drooling was noted a little later. Cottrell acknowledges that stramonium is not a specific, but believes that as long as the body is saturated with it, sufficient symptomatic relief is afforded to justify its use.

DAVIDSON, Newark, N. J.

SUBOCCIPITAL OR LUMBAR PUNCTURE. O. LANGE, Rev. Assoc. paulista de med. **1**:288 (April) 1932.

Lange reviews the objectionable features of lumbar puncture, its accidents and their treatment and its formal indications, such as tumor or traumatism of the spinal cord or blocking of the spinal canal, in which cases the lumbar part of the fluid, on account of its proximity to the lesion and the action of gravity, is more likely to show the necessary elements for diagnosis than if it were collected higher up. In all other cases suboccipital puncture is advisable, easier to perform and innocuous, although appearing more dangerous. To prove his contention, the author cites 2,500 such operations performed in the São Paulo service of neurology since August, 1929, and 1,200 punctures reported by Pinéas, with only three accidents, one of which resulted in a fatality. This compares favorably with the percentage obtained in lumbar puncture. Suboccipital puncture is especially indicated in cerebral tumors and is to be considered as an ambulatory puncture in contradistinction to lumbar puncture, which must be performed in a hospital. Patients can return home immediately and attend to their occupations without suffering any inconvenience. There are three requisites for successful suboccipital puncture: (1) absolute immobility of the patient, (2) correct position of the patient, with the spinal canal in line with the median sagittal line of the head, and (3) introduction of the needle exactly in the median line, from 0.5 to 1 cm. above the spinal process of the axis and perpendicular to it. EDITOR'S ABSTRACT.

VASCULARITY OF PARTS OF THE SPINAL CORD, BRAIN STEM, AND CEREBELLUM OF THE WILD NORWAY RAT (RATTUS NORVEGICUS) IN COMPARISON WITH THAT IN THE DOMESTICATED ALBINO. E. HORNE CRAIGIE, J. Comp. Neurol. **53**: 309 (Oct.) 1931.

The material consisted of nine wild gray Norway rats that were compared with material from albino rats previously reported. The diameter of fifty capillaries in each of eight regions in the central nervous system of six wild Norway rats was measured. The average diameter was found to be a little higher in the wild gray than in the domesticated albino rat of the same species. There is also a tendency for the capillaries in the ventral horn, the twelfth nucleus and the cerebellar cortex to be slightly wider. The total length of the capillaries in the unit volume of tissue was measured in fourteen of the twenty-five regions previously studied in the albino rat. In eight regions the length did not differ significantly. The median longitudinal bundle and motor seventh nucleus are richer in the wild gray rat; the pyramidal tract, dorsal cochlear nucleus and cerebellar cortex are richer in the albino rat. The females were a little richer in every one of the fourteen regions, while the wild gray rat found in Toronto tended to be a little richer than that found in Philadelphia. The relation in point of vascularity between the parts is essentially the same in both forms, though the relative poverty of the cerebellar cortex in the wild animal is noticeable.

ADDISON, Philadelphia.

ALZHEIMER'S DISEASE. K. LOWENBERG and D. ROTHSCHILD, Am. J. Psychiat. **11**: 269 (Sept.) 1931.

That Alzheimer's disease is an atypical form of senile dementia is doubted by Lowenberg and Rothschild, who present two cases with clinical and pathologic observations. Their first patient was a feebleminded adult, aged 59, who had syphilis. He was disoriented, confused and demented. At autopsy, the left cerebral hemisphere was found to be much smaller than the right, with atrophy of the cornu ammonis. With microscopic study, typical Alzheimer plaques were found. Ganglion cells showed large accumulations of lipoid material. The second case occurred in a woman, aged 37, whose psychosis developed acutely at the end of a pregnancy. She was elated, excited and confused, and showed defects of memory. In a second attack, five years later, she exhibited hallucinations, and was wild and

confused. At autopsy, there was found a diffuse dropping out of ganglion cells, with large accumulations of lipoid material in those that were left. Large numbers of Alzheimer plaques were present, but there were no neurofibril changes. This case demonstrates the possibility of a remission in Alzheimer's disease, a previously unreported possibility. On the basis of these observations and following a critical review of the literature, Lowenberg and Rothschild conclude that Alzheimer's disease is really a syndrome with a multiplicity of etiologic agencies, and that it is not necessarily a presenile psychosis.

DAVIDSON, Newark, N. J.

MECHANISM OF VISION: IV. CEREBRAL AREAS NECESSARY FOR PATTERN VISION IN THE RAT. K. S. LASHLEY, J. Comp. Neurol. **53**:419 (Dec.) 1931.

The fifty animals used in this study were adult rats, either hooded or self-colored, from a recent cross between albinos and a local wild strain. The cortex was destroyed bilaterally by thermocautery in each of the chief cyto-architectural fields of Fortuyn, with the exception of the region of the cortex overlying the occipital radiations. Here it was cut away with a knife. In a few animals the visual nuclei or the superior colliculi were destroyed. The animals were tested for perception of distance and for discrimination of visual patterns. Each animal was given ten standard tests. Interruption of the optic radiations of both sides abolishes all capacity to react to visual objects. The ability to distinguish light and darkness is retained. The destruction of a small lateral region in each area striata abolishes permanently the ability to distinguish visual patterns, but leaves the ability to distinguish the position and relative brightness of objects. No other cortical lesion produces any defect in reactions to tests used.

MECHANISM OF VISION: VI. LATERAL PORTION OF THE AREA STRIATA IN THE RAT; A CORRECTION. K. S. LASHLEY and MARGARET FRANK, J. Comp. Neurol. **55**:525 (Aug.) 1932.

In the earlier paper here abstracted, Lashley reported experiments indicating that, after partial destruction of the striate area in the pigmented rat, the discrimination of patterns is still possible unless the anterolateral portion of the area is involved. He interpreted this as evidence that the anterolateral region of the cortex is of greater importance for pattern vision than other parts of the striate area. These lesions involved the underlying projection fibers of the optic radiation as well as the cortex. Attempts to destroy the cortex without injury to the radiation fibers were unsuccessful, but six cases in which there were only slight injuries to the optic radiation are reported. Vision was not more seriously disturbed after destruction of the anterolateral part of the area striata than after limited injuries to other parts of the visual field. The failure in visual tests by animals with injuries in this part of the field, as previously reported, the authors now state as due to interruption of the optic radiations and not to destruction of cortical tissue.

ADDISON, Philadelphia.

MICROCEPHALY AND FEEBLEMINDEDNESS. W. KUERBITZ, Arch. f. Psychiat. **94**:172, 1931.

The author presents a study of four cases of feeblemindedness with microcephalic measurements of the skull. The first case was that of a girl, aged 8½ years, with a history of consanguinity in the parents, whose intelligence quotient was 35. The circumference of the head was 44 cm. The second case was that of a boy, aged 7 years, also with a history of consanguinity of the parents, whose intelligence quotient was 31; there were mongolian features and convulsions; the Wassermann reactions were negative, and the circumference of the head was 39.5 cm. In the third case, that of a girl, aged 9 years, with an intelligence quotient of 54, the circumference of the head was 40 cm. In the fourth case, that of a girl, aged 9 years, whose mother was feebleminded, the intelligence quotient was 33, and the circumference of the skull was 46 cm. In all four cases

there were definite physical underdevelopment and decreased resistance to disease, and in three the skulls were thickened. All of the patients showed a tendency to increase psychomotor activity and a poor vocabulary. The author undertook a study of the artistic performance of the children, finding that in case 1 there was just a mixture of lines without any form; in case 2, a slight increase in tendency toward form; the patients in cases 3 and 4 showed ability for form, with at times expressions similar to those one finds in mentally diseased persons.

MALAMUD, Iowa City.

THE PRESENCE OF RAMIFIED CELLS SIMILAR TO MICROGLIA IN THE HEART, STRIATED MUSCLES AND URINARY BLADDER. F. VISINTINI, Riv. di pat. nerv. **37**:36 (Jan.-Feb.) 1931.

In order to contribute to the identification of the microglia with the elements of the reticulo-endothelial system, F. Visintini has impregnated various organs with the silver method of Bolsi and has obtained positive results in the heart, in the voluntary muscles and in the urinary bladder as indications of the presence of elements similar to microglia.

These elements are small and ramified. Morphologically comparable to the microglia found in the nervous system, they can be identified with the cells of Zimmermann and Rouget belonging to the histiocytes. These elements are seen free between the muscle fibers and surrounding the blood vessels, around which they disclose several prolongations. The author suggests the possibility of a contractive function of the cells leading to contraction of the blood vessels. In the voluntary muscles the same cellular elements are larger and more ramified. In the urinary bladder the elements recall the interstitial cells of Cajal, as described in the pancreas and in the intestines.

FERRARO, New York.

SURVEY OF PROBABLE PROGNOSTIC FACTORS IN THE TREATMENT OF GENERAL PARALYSIS. W. A. CALDWELL, Brit. M. J. **2**:1129 (Dec. 19) 1931.

This report is based on observation of seven or eight hundred patients certified as mentally defective and treated for dementia paralytica. Various treatments were utilized, including malaria, relapsing fever, sulphur in olive oil, tryparsamide or a combination of any of them with various other arsenical preparations. In regard to treatment, the author believes that the best results were obtained by a preliminary course of tryparsamide followed by injection of the malaria-producing organism, and this in turn followed by a subsidiary course of organic arsenic.

As to other factors that seemed to influence prognosis, it seemed that previous pregnancies tended to make cure more favorable and to double the chances for a remission. Patients below the age of 40 years make the most economically satisfactory remissions. Expansive and manic patients gave a much better response to treatment than did the depressed and juvenile patients. The ability to remember the primary infection and its treatment is of prognostic value. The author does not indicate an explanation as to why it should be so.

FERGUSON, Niagara Falls.

CHOROIDEREMIA. WALTER R. PARKER and F. BRUCE FRALICK, Arch. Ophth. **6**:213 (Aug.) 1931.

An abstract of this article is presented because of the probable interest of the embryologic development. Choroideremia is, undoubtedly, a faulty development of the choroid wherein only the macula appears, the remaining portion of the choroid being absent, and occurring because of the absence of all posterior ciliary vessels save those that appear as a blood supply to the macula. If so, the short posterior ciliary arteries supplying this particular region are a definite and distinct anatomic entity. Embryologic studies make this possibility a logical probability correlating colobomas of the retina and the choroid and colobomas of the macular with choroideremia.

SPAETH, Philadelphia.

VALUE OF NEUROSURGERY IN CERTAIN VESICAL CONDITIONS. J. R. LEARMONTH, J. A. M. A. **98**:632 (Feb. 20) 1932.

A review of the nerve supply to the bladder and a description of the method of exposing its sympathetic nerves are given. The author considers sympathetic neurectomy to be indicated in cases of vesical paralysis, in which the lesion is situated in the parasympathetic pathway, and the sympathetic pathway is intact. The patient must be continent, and renal function satisfactory. Sympathetic neurectomy, alone or combined with a local procedure, has proved efficacious in dealing with spasmodic conditions of the neck of the bladder. Sympathetic neurectomy will relieve pain due to painful contractions of the bladder in about 50 per cent of cases; it does not directly relieve frequency.

EDITOR'S ABSTRACT.

THE VASCULAR SUPPLY OF THE ARCHICORTEX OF THE RAT: III. THE WILD NORWAY (MUS NORVEGICUS) IN COMPARISON WITH THE ALBINO. E. HORNE CRAIGIE, J. Comp. Neurol. **52**:359 (June) 1931.

In the brains of eight Norway rats the author found that the average diameter of the capillaries in three of the layers of the hippocampal formation was slightly, but not significantly, higher than in the brains of albino rats previously studied. Capillary richness in the hippocampal formation averaged significantly lower in the wild Norways. The relative vascularity of each of the seven layers was practically identical in the Norway and the albino rats.

ADDISON, Philadelphia.

CATATONIC SYMPTOMS IN MAN FROM THE STANDPOINT OF ANIMAL PSYCHOLOGY. H. KUTTNER, Monatschr. f. Psychiat. u. Neurol. **78**:30 (Jan.) 1931.

A careful examination of many animals reveals the fact that their normal reactions resemble in many respects the behavior of catatonic patients. Hence it is probable that phylogenetically old psychomotor mechanisms, which were of use in earlier stages of development, play a rôle in the symptom complex of catatonia. However, catatonia cannot be regarded as a complete regression to lower phylogenetic levels, for in many cases it is apparent that higher psychic activities are not eliminated.

ROTHSCHILD, Foxborough, Mass.

UNEXPLAINED GASTRIC ACIDITY. W. S. POLLAND and ARTHUR L. BLOOMFIELD, Arch. Int. Med. **48**:412 (Sept.) 1931.

Twenty-five cases of achlorhydria gastrica are reported. In none was there any evidence of pernicious anemia, carcinoma or posterolateral sclerosis. Ninety-one per cent of the patients were over the age of 40. Most of them were free from gastro-intestinal symptoms. Study of the blood, neurologic examinations and roentgen visualizations all gave negative results. The authors believe that unexplained gastric anacidity may be encountered in from 3 to 5 per cent of patients in a medical clinic.

DAVIDSON, Newark, N. J.

NEW EXPERIMENTS ON THE GAS METABOLISM OF THE CENTRAL NERVOUS SYSTEM DURING STIMULATION AND EXCITEMENT. J. v. LEDEBUR, Arch. f. d. ges. Physiol. **227**:343, 1931.

The production of carbon dioxide in the spinal cord of the frog was studied. The increase of the reflectoric excitement of the spinal cord (strychnine spasms) had no measurable effect on the production of carbon dioxide. This metabolism was distinctly increased, however, by direct electrical stimulation of the cord. The author concludes that it is not yet proved that excitement increases the gas

metabolism of the nervous system. So far as such an increase has been observed, it may be an additional effect of the stimulating electrical currents.

SPIEGEL, Philadelphia.

STUDIES IN THROMBO-ANGIITIS OBLITERANS (BUERGER): VII. THE BASAL METABOLISM. SAMUEL SILBERT and MAE FRIEDLANDER, J. A. M. A. **96**:1857 (May 30) 1931.

Silbert and Friedlander made a study of the basal metabolism in fifty cases of thrombo-angiitis obliterans, in twelve men who were heavy smokers, and in ten persons with circulatory impairment due to atherosclerosis. An average reading of minus 16.2 per cent was obtained in the patients with thrombo-angiitis obliterans. An average of minus 15.1 per cent was obtained in male smokers. The atherosclerotic group showed a metabolism that was normal or slightly above normal. The average reading was plus 9 per cent.

EDITOR'S ABSTRACT.

COMPLEX METHOD FOR THE STUDY OF THE HIGHER NERVE FUNCTION, USING PAVLOV'S METHOD OF CONDITIONED REFLEXES. W. KRIASCHEW, Arch. f. d. ges. Physiol. **228**:295, 1931.

If a conditioned reflex on salivation or a defense reaction develops, other reflexes also develop, for instance, of respiration, heart action, contraction of skeletal muscles in the limbs or tail muscles and phonation. First a conditioned reflex of respiration develops; a little later the reflexes of skeletal muscles, of the tail and of phonation, and last of all a conditioned local reflex (salivation or defense reaction). When these reflexes disappear the opposite order is followed.

THE INFLUENCE OF THE PITUITARY BODY ON THE ACTIVITY OF STRIATED MUSCLES. H. J. DEUTICKE, Arch. f. d. ges. Physiol. **227**:24, 1931.

After total extirpation of the pituitary gland in frogs, a weakness of the skeletal muscles, which are easily tired, is observed. By treating the animals with extracts of the anterior and posterior lobes of the pituitary gland (praephyson and physormon), this consequence of the extirpation of the gland could be compensated in the majority of the experiments. In normal frogs the injection of these extracts had no effect on the activity of the skeletal muscles.

THE DEVELOPMENT OF CONDITIONED REFLEXES ON DIURESIS. K. M. BYKOW and I. A. ALEXEJEW-BERKMANN, Arch. f. d. ges. Physiol. **227**:301, 1931.

Conditioned reflexes on diuresis were observed if the kidney was normal as well as if it was denervated. This is explained by the theory that these reflexes act not only on the nerves of the kidney but also on hormonal glands which regulate the function of this organ.

SPIEGEL, Philadelphia.

Society Transactions

PHILADELPHIA PSYCHIATRIC SOCIETY

Regular Meeting, March 18, 1932

CLARENCE A. PATTEN, M.D., *President, in the Chair*

NEUROLOGIC CONDITIONS IN THREE HUNDRED AND NINE MENTALLY DEFECTIVE CHILDREN. DR. ROBERT MATTHEWS and DR. ROBERT MCDADE.

A group of 309 mentally defective children in the Philadelphia institution for the feebleminded was examined from the standpoint of organic neurologic defects. Slightly more than 50 per cent of the group have definite and unmistakable neurologic conditions. There seems to be a considerable correlation between the degree and type of neurologic defect and the intellectual level. This seems to be especially true in cases of infantile spastic diplegia. The low psychologic rating in spastic cases may in some instances be due to the patient's inability to articulate or to perform purposeful movements. Some unknown intra-uterine factors seem to be of more importance in the production of the spastic diplegia in this group than were birth trauma, postnatal disease or injury. Ten per cent of the patients with neurologic manifestations have abnormal movements, double athetosis being the most common type. A number of patients have a positive Babinski sign without further evidence of pyramidal tract disease. One boy, aged 15, with tuberous sclerosis is among the group of patients examined. Approximately 5 per cent of the patients in the institution are of the type of mongolian idiots; 1.9 per cent of the entire group have a positive Wassermann reaction of the blood.

CHANGING CONCEPTS IN THE EDUCATION OF MENTALLY DEFECTIVE PATIENTS. MARY M. WOLFE.

The law establishing the Pennsylvania Village for Feebleminded Women (now the Laurelton State Village), passed by the legislature in 1913, was definite in certain provisions. It was to be "entirely and specially devoted to the reception, segregation, detention, care and training of feebleminded women of child-bearing age." The age limits set in the law were from 16 to 45. It was also stated in the act that "it is specifically determined that the processes of an agricultural training shall be primarily considered in the educational department, and that the employment of the inmates in care and raising of stock and the cultivation of fruits, vegetables, roots, et cetera, shall be made tributary to the maintenance of the institution." No definite mention of academic training is made in the original law. With regard to release, the law provides that "when, in the opinion of the board of trustees, it appears probable that the mental condition of any inmate of said institution has so improved that her release will be beneficial to such inmate, and not incompatible with the welfare of society, the said board may recommend the discharge of such inmate to the court committing her to said institution . . . . whereupon the said court may, in its discretion, after hearing all persons desirous of being heard in the premises, issue an order, under the seal of the court, upon the said board, to discharge the said inmate from the said institution."

These provisions of the law establishing the Pennsylvania Village for Feebleminded Women present a clear picture of the general opinion held with regard to mentally defective patients, especially mentally defective women, in 1913. They say in so many words, "here is a group of persons whose children will invariably inherit the mental defects of their parents. They are a menace to society; therefore these women must be segregated in an institution for the whole of the child-

bearing period, so that they will not have children who will inherit their mental defects." They say further, "These women will have reached adulthood when they are admitted to the institution. Little or no scholastic training will have to be provided for them. They should, however, learn various forms of farm work to keep them busy and reduce the cost of their maintenance." They also say, through their provisions for release, "Mentally defective women are a menace to society. Their release must be made difficult. It is not wise to leave to the courts, on which various types of pressure may be brought, the discharge of these girls and women. It is better to have the initiative for release come from the board of trustees of the institution. They are more likely to realize the seriousness of this situation. Let them make a recommendation to the court when any woman is fit to leave the care of the Village. This will properly protect society from their inadvisable or overhasty release." The point of view has changed materially since this law was enacted in 1913.

Through the failure of the legislature to appropriate funds for the Pennsylvania Village, over six years elapsed between the time it was established and its opening. The first girl was admitted on Jan. 2, 1920. During that interim two significant things affecting the situation relative to the feebleminded occurred: Dr. Bernstein of Rome State School, Rome, N. Y., had established colonies for defective women, and psychologic tests had been made of the men drafted for service in the World War. In 1920, Dr. Bernstein's experiment was being watched closely and had aroused a great deal of hostility. The results of the psychologic studies of the drafted men, together with their evaluation, were just beginning to be published.

Within a year or two of the opening of the Village, several things became increasingly patent. One was that the provisions of the law made the population of the institution practically static. As soon as the legislature granted appropriations for new buildings and these buildings were filled, few additional girls could be admitted until more new buildings were provided. In one biennium only seventeen girls were admitted. The fact had to be faced that, at that rate, segregation would have little effect in solving the problem of the feebleminded, and that wisdom dictated the formulation and investigation of any methods whereby the institution's population might be made more mobile. A second bad effect was the depressing and unhealthy atmosphere of the institution brought about through the realization on the part of the girls that their stay at Laurelton was practically a life sentence. The spirit of "What is the use?" was abroad in the land. "What is the use of working? What is the use of being good? We are here for life, anyhow."

The employment of a skilled research psychologist to study the girls as they were admitted was one of the wisest moves made in the early history of the village. This insured full psychologic records beginning with the first admission. These included not only the mental levels of the girls, but their industrial capacity as well. In addition, researches were carried on for four years to ascertain the lowest mental ages at which various industrial tasks could be performed. It was learned that these limits could be fixed with reasonable accuracy, but that personality traits had a decided effect on the results. These researches were then used with success in assigning the industrial work of the institution.

In the early days of the Village no attention was paid to academic education. The histories of the girls and contact with them revealed that the great majority of those admitted had had such unfortunate experiences in their school lives prior to admission that a marked aversion to anything savoring of school had developed. The school histories, as learned from the records and told by the girls themselves, were most enlightening as to the reasons for this aversion. A table showing the mental ages of the girls and the various school grades they had attained yielded interesting information. For example, one girl, with a mental age falling in the group between 5 years and 5 years and 11 months was recorded as having reached the seventh grade; another, with a mental age falling between 3 years and 3 years and 11 months, was recorded as having reached the sixth grade. Theirs were unquestionably courtesy promotions and were made without justifiable excuse. It is not surprising that girls in situations such as these, trying to work beyond their

mental depth, should have disliked school or should have expressed themselves as hating to be considered stupid and being called "dummy" and "boob," not only by their classmates, but also, at times, by their teachers.

Many of the girls at Laurelton are delinquent defectives. A comparison of the school histories and the records of delinquency shows, in many cases, an interesting connection between the school lives and the delinquency. In a number of instances it can be shown that the first step toward delinquency was made when school life became unbearable. In an effort to adjust themselves they began to play truant. This in turn led to their becoming the prey of unscrupulous people, who took advantage of them or introduced them to lives of prostitution or crime.

In the light of the foregoing facts, by the latter part of 1922 it became evident that something must be done to increase the movement of population at the Village and to relieve the hopeless atmosphere of the institution. Further studies on the heredity of feeblemindedness had cast doubt on the invariable inheritance of mental defect. Dr. Bernstein's system of colonization and parole had met with a certain degree of success; the psychologic tests of drafted men had shown that, although a considerable number were of subnormal intelligence, they had been self-supporting and had led useful lives in their communities; scientific work at Laurelton also had advanced sufficiently to make it probable that the girls in residence were capable of acquiring much more academic knowledge and industrial skill than they had attained prior to admission. It was deemed possible in certain cases, by breaking down old habits and forming new ones, together with the fostering of self-respect and group responsibility, to increase the likelihood of adjustment to life outside. Therefore, with the consent of the Department of Welfare, it was decided to institute a system of education and industrial training at Laurelton to prepare girls who were expected to become eligible for parole for a modified system of colonization and parole, and to set certain academic, industrial and social standards that must be reached before any girl was deemed ready for parole. At this time the original law establishing the Village stood in the way of any progressive work of this kind, but the Mental Health Act of 1923, changing the name of the institution to Laurelton State Village, removed many of the restrictions of the original act and made a progressive program possible.

In establishing academic training it was necessary first to overcome the distaste of the girls for school. This was accomplished by Dr. Vanuxem, the psychologist, in a number of ingenious ways. The first school was opened at Laurelton on Jan. 1, 1923. It was most primitive. As no schoolroom was available, the sessions were held at a table in the corner of a dining room, between meals. The almost immediate success of the experiment was encouraging. The schools have developed from this nucleus until at the present time Laurelton has four teachers, with fairly well equipped classrooms, and the schools are constantly being improved. All grades from the third to the eighth are now being taught, and this year a certain amount of departmental work was included in the school program. The classes are limited to twelve, thus insuring the necessary individual teaching. The advancement made by some girls has been surprising. Over 100 girls who had had several years of schooling prior to admission, with but little benefit, have learned to read and write. The general scholastic ability among the girls has improved, so that the Village library has one of the largest circulations of any institution in the state. The letters composed and written by some girls are creditable, and the girls have made good progress along other scholastic lines. When a girl has completed the eighth grade, or her mental tests and general school accomplishments show that she can receive no further benefit from school attendance, the academic education is considered finished.

While the schools were being developed, the industrial work of the institution was being systematized to form a vocational program for girls whose qualifications were such as to make them prospectively eligible for parole. As no rooms for vocational training were available, the every day work of the Village was utilized for industrial training. The girls were taught various types of domestic service, including general housework, chamber work, hand laundering, waiting at table and cooking. They were also taught commercial laundering. No set time was fixed

for completion of the training in any one project. Some girls took longer than others to complete their training. No girl was considered proficient until she had acquired sufficient skill in her job to earn her living by it.

In the fall of 1925 the first girls were paroled. Within a short time, twenty girls had been placed in various parts of the state. Within five years, this number had increased to an average of sixty. A summation of the parole work at Laurelton made at the end of six years yields the following results: With the type of girls at present in residence, mainly delinquent and mentally defective persons, not over 15 per cent can be paroled. A group of less troublesome mentally defective girls would probably permit of a somewhat larger percentage of paroles. Definitely specialized training adapted to this type and close and careful supervision are essential for successful parole of mentally defective persons. During this six year period, 85 per cent of the paroles were successful, and only two of the whole number of girls paroled gave birth to illegitimate children. A computation of the financial benefits accruing from the parole system shows that from 1925 to 1931, approximately $60,000, exclusive of not over $2,000 per year for expenses, was saved the taxpayers of the state through paroling the girls, to say nothing of the increased number of girls who could be admitted.

The Laurelton State Village now has in residence 660 girls, with from 60 to 65 additional girls on parole. The number in residence is about 100 above the standard capacity of the institution. The institution has a waiting list of over 500 applicants; many of these cases are urgent, and the pressure for places is great. New buildings to be erected within the next year will care for not more than half of those on the waiting list. Everything is being done to accommodate as large a group as present facilities will permit, but the long waiting list and the pressure for places show that the full need is not being met. One additional resource would unquestionably help, for it strikes at the root of the trouble; it has not as yet been fully tried. With no intention or desire to criticize the public school system unfairly, it must be pointed out that for twelve years Laurelton State Village has been working with its failures, also that a number of the failures have been transformed at Laurelton, by methods somewhat different from those in use in the public schools, into moderate educational successes and useful, self-supporting units of society. Those who have participated in the experiment believe that the methods used from the beginning of the school lives of mentally defective patients would, in many cases, obviate the necessity for institutionalization and prevent a number of girls from becoming delinquent. It costs approximately $215 a year to educate a pupil in the public schools, and $350 a year to educate, train and maintain a pupil in a state school. The difference is appreciable and is of interest to the taxpayer. As a basis for such a program in the public schools it would be necessary to ascertain the mental level of all children entering the first grade. This can be done by the use of group tests, buttressed by more accurate tests made by competent testers for children who have failed in the group tests. From the first grade on, any child who fails of promotion should be given a mental test at the first failure, to discover, if possible, the cause of the failure and lessen the likelihood of the development of an inferiority complex, which frequently occurs when a child is allowed to become three years retarded before understanding, sympathetic help is extended.

Children with intelligence quotients between 50 and 70 should be placed in special schools. The educational programs should be patterned after the combination scholastic and industrial school curricula in use at the best state schools. These pupils should be closely watched, and as they near the limit of their mental capacity there should be a gradual shift in the work; less and less emphasis should be placed on academic branches, and industrial training should become more dominant.

Many of the larger centers of population have established special schools. These constitute a fair start; but they are not sufficiently inclusive, most of them being operated without definite knowledge of the mental levels of all school pupils, and the training given is not that best adapted to develop the mental powers of this group to fullest capacity. These schools should be greatly expanded and placed on a better and more practical basis.

Certain groups, such as those in the lower grades, antisocial persons, those with bad homes and those in the rural sections, where there are too few defective patients to form a special class, will still require care in a state school. It will also be necessary from time to time to remove certain defective students from the public schools and place them in the state schools if obnoxious traits develop or, for any reason, it seems more advisable to institutionalize them. The time should come, however, when many more defective persons will be able to live in their homes and be taught satisfactorily in the public schools, with more comfort and pleasure to themselves and their parents, and more profit to the taxpayer, and without being a detriment to the general public.

DISCUSSION

DR. E. A. WHITNEY, Elwyn Training School: We have made no neurologic studies of the material at the Elwyn Training School, as the children who are admitted comprise a special group. We specify that children must be of a trainable type; thus we eliminate most of the lower grades. We still have a number of them, but they are of the psychologically older group. We have some who are old physically who do have interesting neurologic conditions, and there are about forty mongolian idiots, one with spastic diplegia and one with epilepsy. Dr. Matthews spoke of six or seven children with positive Wassermann reactions; we had one with a positive Wassermann reaction in a group of forty studied several years ago. I wish to ask Dr. Matthews if he has made any study of possible disturbances of sensation in this group of 309 children.

From the standpoint of Dr. Wolfe's paper, at Elwyn we have three general phases of education, classified as follows: (1) general academic work from kindergarten to the level of sixth grade; (2) special educational activities, such as physical training, musical training (in band, violin and rhythm band) and various forms of industrial arts (sloid, printing, weaving, embroidery, basketry, raffia work and other forms of handwork) and (3) training for institutional aid. Children in this group are taught to do tasks which will make them useful aids in the economy of the institution. The tasks include sewing, laundering, housekeeping and cooking, for girls, and farming, carpentry, painting, tailoring, baking and engine room work, for boys. Dr. Wolfe made a point of the small classes, twelve in a class. We cannot have classes so small at Elwyn, but we do have them in groups of twenty or thirty. We do not have a parole system in our institution, and I cannot compare our results with those of Dr. Wolfe.

Dr. Wolfe stresses psychometric tests, but I do not believe one can rely entirely on the intelligence quotient, as this is often too high. One child was admitted with a stated intelligence quotient of 84, but when tested on two subsequent occasions he showed an intelligence quotient of 48 and 44. I think that Dr. Wolfe's point regarding additional tests is well made.

DR. MARY VANUXEM, Assistant Superintendent, Laurelton State Village: Among other things that Dr. Wolfe mentioned were the inferiority complexes found in our groups. We have two divisions, the first in which a definite inferiority complex occurs: "I can do nothing. What is the use of trying?" and the other in which a defense mechanism, an apparent superiority complex, masks an inferiority feeling. A talk with girls of the latter type soon shows that this is bravado.

Every girl who enters the institution is told that she has to do certain things before she can leave, and that it is a training school. Unfortunately, people will tell the girls, "You are going away for life. You are going to be sent where you can never be reached again." As I admit the girls, I endeavor to break down this difficult attitude. The first thing I tell a girl is that she has to reach three standards: first, a certain amount of schooling; second, that she must learn three trades before she can go out; and third, that she has to be able to live outside. Sometimes this is difficult to understand at first. We never tell a girl what grade she is in. We have an 8:30, a 10 and a 1 o'clock class. If a girl is not getting along successfully and cannot do the required grade work, we arrange

it so that the 10 o'clock class is occupied by her industrial work, which will take her out of this particular class, and put her in another group. She is followed throughout her academic work. Whether she stays one, two or three years, the tasks are not the same, and if she does not complete work this year she merely is transferred to another teacher in the next year, who uses another textbook. She is made to feel that she is a normal person and not a dummy. The third standard and the hardest is the one as to whether she can live outside. We do not expect the impossible, but we do ask these patients to be thrifty. I should like to know how many normal people are saving $50 a year, which is the sum required at Laurelton. One girl who has been out for five years has $500, some life insurance and a saving fund. This is good for a feebleminded girl with an intelligence quotient of 60. If the girl cannot save $50, the sum required except when she is helping her family, when the amount is lowered, an investigation is made. We have had to adopt these measures lately; otherwise families would have suffered. Some of these women are paying board for illegitimate children, and in this way they feel that they have some responsibility.

DR. GERALD H. J. PEARSON: It was mentioned that sometimes there are mistakes in psychometric evaluation owing to an inadequate method of testing. That is true, but there are also cases in which an adequate examination gives a low intelligence quotient in a child whose intelligence is at least average. In these children (we have seen one or two at the Child Guidance clinic, and some cases have been reported in the literature), inquisitiveness is repressed either for internal reasons or because of severe parental restrictions, and consequently the child inhibits the desire to learn or to exhibit what it learns. Therefore on a psychometric examination they give an appearance of being feebleminded because the tests indicate an intelligence quotient of perhaps 65. Following analysis, the intelligence quotient becomes much higher. I do not know whether this condition eliminates itself without treatment as the child grows older, or whether the untreated person goes through life apparently feebleminded. Consequently, it must be borne in mind that even though psychometric examinations are made perfectly, the result does not always indicate the real ability of the child.

Another point is the question of the association of feeblemindedness with delinquency. Both the superior child and the subaverage child have difficulties in adjusting themselves to the average social milieu, and such difficulty contributes somewhat to certain delinquencies, such as truancy, though all of these children are not truants. In general, however, I should say that delinquency is not the result of mental deficiency, although delinquent behavior may be found among deficient persons. I wish to ask: How early is it thought advisable to have a mentally defective child admitted to an institution? One sees children of 3 or 4 who are mentally defective. It is my belief that such children are especially suitable for expert care and would benefit from special training which they cannot get at home, and that many institutions do not like to take children of this age.

DR. M. A. TARUMIANZ, Superintendent Delaware State Hospital: Is it worth while to consider the small number of feebleminded who are colonized in institutions and forget the majority who are at large? To my knowledge, about 6 per cent of the population belongs to the group at large, and yet we are thinking constantly about those who are institutionalized and overlooking the necessity of protecting society from the others. The majority of those classified as morons can exist outside under supervision, such as that of a mental hygiene clinic with an adequate number of social workers, and can be healthful members of the community if they are sterilized. In Delaware, where we have a sterilization law, not a single sterilized child has become a prostitute, contrary to the usual thought that if a moron is sterilized she is certain to become a prostitute. There is some reason to believe that the feebleminded who are not sterilized will become prostitutes sooner than those that are. In reference to Dr. Matthew's statement regarding the percentage of syphilis among congenital morons, a negative Wassermann reaction of the blood or spinal fluid does not indicate freedom from congenital syphilis.

DR. ALFRED GORDON: Dr. Wolfe spoke of mental deficiency from a purely intellectual standpoint, yet frequently one sees children labeled by teachers as mentally defective who, on examination, reveal that they are not defective. Intellectually they may be normal, but they are emotionally deficient. Dr. Wolfe mentioned sending out some of these girls after a certain amount of training, on the recommendation of a committee. One knows that state institutions are controlled largely by laymen who do not understand these problems. In my judgment the control of discharges should be in the hands of a consulting staff of psychiatrists.

DR. MARY M. WOLFE: For twelve years we have been studying mentally defective patients practically unadulterated. I have learned that there is a great deal that we do not know about them, and that we have not much more than scratched the surface. I have no illusions about the mentally defective person. I do not want it to be thought, because I advocate education in the public schools, that I do not recognize the importance of segregation and other measures. I do. If we have been able to institutionalize 660 of a group of 8,000, and there are 12,000 in the state, and we have a waiting list of 500, where are these people? They are in their homes, in jails, in houses of detention and running on the streets. Are we going to wait until the legislature can provide buildings at Laurelton, or are we going to make an effort to keep that number of people under intelligent training until we can care for them? Our task is to give the girls the three R's of academic training, enough to suffice practically. It is not a college education. They have just three jobs in which they are proficient. We know that if employees are laid off anywhere, they will be the first to go. If no other method is possible whereby they can earn an honest living, they will turn to the easiest way. The girls are under indefinite parole. We visit them; we watch them; we keep close supervision over them. If this were not so, we should not have the record of only two illegitimate children among those paroled. Some of the girls who are paroled do have illegitimate children, but taking into consideration the number of girls running around without supervision who can have proper training in an institution by taking the places of those paroled, I think that the work is worth while. We adopt these measures, not because they are ideal, but because they are practical.

In regard to sterilization, it is the people outside who must push the matter, for there is no question that selective sterilization is a good thing. I do not see why girls who cannot live outside should be sterilized, but selective sterilization would help tremendously in these problems. I do not believe that girls are likely to become spreaders of diseases if they are sterilized. Leisure is the danger time for these girls, and it must be provided for. Teaching them to read, embroider, crochet and make their own clothes is of value. We find that many girls come to us with a lower intelligence quotient than we find when we examine them. If we find too great a discrepancy, we invite some one from the Bureau of Mental Health to examine them and check with us. We have been rather particular in this check-up. We take the emotional side into consideration and do not, as a rule, give the girls mental tests for a month or two after admission to the institution. Something was said about academic work and parole. If academic and industrial standards are set up, the lower-grade girls would immediately be excluded from parole; most of the girls are morons. Failure in school, if the girls know that it is failure, is detrimental, and we try our best not to discourage them by not letting them know when they fail. They have had too much discouragement before they come to us. We try to encourage them. The present depression has interfered with parole, as there are not enough jobs for the girls. We find only 15 per cent who are fit for parole. There are two groups of girls — those who are active prostitutes and those who would not seek prostitution in any environment. If they are allowed to play truant from school, it is the former group that will fall into prostitution naturally. The questions of parole and special classes affect the whole problem of the feebleminded. If a certain number of girls are paroled under supervision, they can be kept at much less cost, and an equal number can be taken into the institutions who have not been under supervision at all. In that way the problem of the feebleminded is affected.

LOS ANGELES SOCIETY OF NEUROLOGY AND PSYCHIATRY

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CYRIL B. COURVILLE, M.D., *President, in the Chair*

RELATIVE INCIDENCE OF OTOGENIC INTRACRANIAL LESIONS IN A SERIES OF EIGHT THOUSAND CONSECUTIVE AUTOPSIES. DR. DELBERT H. WERDEN.

Statistics from any source have a number of definite limitations, depending on the local situation and the circumstances under which the work was done. This

Intracranial Complications of Infections of Middle Ear and Mastoid

	Incidence, Cases	Total Cases
Septic meningitis		91
Bacteriology (from stained smears)		
Pneumococcus	59	
Streptococcus	17	
Staphylococcus	1	
B. influenzae	3	
Double infections	3	
Undetermined	8	
Abscess of the brain		23
Temporal lobe (6 left, 2 right)	8	
Parietal lobe (both right)	2	
*Frontal lobe (left)	1	
Occipital lobe	0	
Cerebellar (6 right, 1 left)	7	
Subdural (1 with right temporal lobe abscess)	2	
Extradural abscesses	3	
Venous channel thrombosis		23
Lateral sinus thrombosis	20	
Unilateral 10		
†Bilateral and complicated 10		
Jugular bulb thrombosis	1	
Thrombosis internal cerebral vein	1	
Cavernous sinus thrombosis	1	
Arterial channel thrombosis		2
Both cases were of thrombosis of the homolateral internal carotid artery, one with coincident thrombosis of the homolateral vertebral artery and basilar artery		
Total number of lesions		139

* This was associated with a bilateral otitis media, which was more pronounced on the right.
† Of these cases with complications, seven were associated with cavernous sinus thrombosis, four with thrombosis of the superior longitudinal sinus and two of the internal cerebral veins. One case of bilateral lateral sinus thrombosis was associated with an abscess in the right temporal lobe, cavernous sinus thrombosis, thrombosis of the superior and inferior petrosal sinuses, extradural and subdural abscess (rhinogenic) and septic meningitis.

certainly is the case in a study of the secondary intracranial lesions consequent to infections of the middle ear and mastoid. Autopsy statistics tend to reveal accurately the incidence of the more serious and fatal complications, such as meningitis or extensive thrombosis. Perhaps a rough estimate might also be made of the incidence of abscesses of the brain, inasmuch as the majority of those located in the cerebellum and approximately from two thirds to three fourths of those in the temporal lobe prove fatal, depending on the local circumstances. Many other lesions, such as pachymeningitis externa, extradural abscess and mural thrombosis of the lateral sinus, are essentially surgical, and there is a tendency toward recovery after operation. This is notably true in cases of "encephalitis" that may result in abscess of the brain.

The autopsies in this series were done by general pathologists who were not primarily interested in all the possible ramifications of the problems presented. Undoubtedly other smaller gross lesions and many microscopic lesions were entirely overlooked for want of critical study in each case.

. The accompanying table includes the various intracranial complications of infections of the middle ear and mastoid that have been seen at autopsy at the Los Angeles County General Hospital in the last fourteen and a half years. The series includes 8,000 consecutive examinations, and the data were collected from the records of the department of pathology. The lesions have been listed separately, so that the figures represent the incidence of a lesion rather than of a case; i. e., a brain abscess complicated by septic meningitis will be listed under both categories.

In one case septic meningitis had become chronic, and adhesions at the base had resulted in an extensive internal hydrocephalus. In a few cases, tuberculous meningitis was associated with otitis media, the meningeal symptoms leading the clinical observer to believe that an otogenic complication was present. The frequency of septic meningitis as a single complication in older persons varied from some current ideas. In forty-three cases of septic meningitis unaccompanied by other complications, twenty-two persons were 15 years of age or less, with an average age of 4.4 years. In twenty-one persons over 15 years of age, the average age was 40 years. In these forty-three cases, about three fourths of the meningitis followed acute otitis media and mastoiditis, even in persons over 15 years of age. Of cases following chronic otitis media, one fourth showed one or more other associated intracranial lesions.

SYMPTOMATOLOGY OF OTOGENIC ABSCESS OF THE TEMPORAL LOBE. DR. J. M. NIELSEN.

For about two years I have been studying the intracranial complications of otitis media in patients entering the Los Angeles County General Hospital, and I have investigated the hospital case records in cases of abscess of the brain for the past ten years. Following the method of von Bergmann, in this presentation, the symptoms of abscess of the temporal lobe are described under the headings of: (1) general symptoms, or those due to the presence of pus in the body; (2) symptoms of the ear; (3) general symptoms of the brain and symptoms of brain pressure; (4) local brain symptoms and (5) meningeal symptoms.

1. General Symptoms: These include rise of temperature, chilly sensations, bradycardia, anorexia, loss of weight, coated tongue, fetor oris, constipation, leukocytosis and pleocytosis of the spinal fluid. Of these, only two can be discussed briefly: temperature and pulse rate. In the first (encephalitic) stage of abscess of the brain there is a distinct rise of temperature, lasting usually for a few days. As encapsulation begins, the temperature falls, usually reaching a low normal. With little fluctuation this continues until the abscess ruptures or the patient dies of medullary failure, just before which the temperature again rises. Slowing of the pulse may be detectable for only a few minutes at a time, and hence the pulse rate should be taken every two hours or oftener. The pulse may be only relatively slow.

2. Ear Symptoms: It is in cases of chronic otitis media, rarely of acute otitis, that abscess of the brain develops. It is commonly stated that intracranial complications appear when drainage ceases. Drainage may continue and yet an abscess result. The presence of cholesteatoma or a sclerosed mastoid is of great importance, because they indicate chronicity and lack of proper drainage outward. When a mastoid is operated on, an erosion through the tegmen may actually lead directly into an abscess. If the dura is laid bare and an extradural abscess drained, acute encephalitis will often subside. One cannot overemphasize the importance of diagnostic surgery. Cooperation between the otologist and the neurologist is of great value to the patient.

3. General Brain Symptoms and Symptoms of Brain Pressure: The most constant symptom found is headache, which is rarely absent. It is frequently confined to the homolateral side. Gastro-intestinal symptoms are nearly always present. First, the patient refuses food; then complete anorexia appears; he next complains of nausea, and only after this does vomiting become a marked symptom. Projectile vomiting is rare. As the terminal stage approaches, there

develop involuntary and incontinent urination. The pulse is rapid in the first stage, but bradycardia appears when encapsulation ensues. The bradycardia seems to be dependent wholly on the increased intracranial pressure. Dizziness and perhaps nystagmus are common symptoms of pressure. The eyegrounds rarely remain normal. While severe choking of the disks is not common, signs of pressure constitute the rule. General convulsions occur in predisposed persons; they are not of localizing value; they are common in childhood. Mental symptoms are practically always present. Early in the disease the patient is restless, tosses about and shows signs of cerebral irritation. In the second stage, all this disappears, but a characteristic state of mind in abscess of the brain, described as slow cerebration, appears. When a question is asked, the patient does not answer normally, but waits so long that one supposes he has not heard and prepares to repeat the question. Just then the patient answers in as short a sentence as possible, perhaps in monosyllables and very slowly, but usually correctly. He lies as in a stupor. This condition may clear up periodically; recurrent attacks of stupor are characteristic of abscess of the brain. Auditory and visual hallucinations are not unusual in abscess of the temporal lobe, and vague, dreamy states are described (probably due to irritation of the uncinate gyrus). When, after an abscess has been drained for any reason, the drain becomes clogged, a train of symptoms appears which have been designated as the "no drainage" syndrome. This is probably a pure picture of abscess of the brain, as there are no fresh developments or complications in the case except lack of drainage. The patient becomes restless, does not sleep well, gets out of bed, or if he remains in it, changes posture often. This continues for a day or two, after which the temperature falls and the pulse rate drops to a bradycardia. It is then noticed that the patient declines food at a meal; complete anorexia develops, and soon the patient vomits. He next becomes drowsy, and later stuporous; as he lapses into coma, he shows involuntary and incontinent urination. If nothing is done, the abscess ruptures, or the patient dies of medullary failure.

4. Local Brain Symptoms: (*a*) Focal brain symptoms appear. Hearing is not materially affected by brain abscess. Speech is often and specifically changed, aphasia being a sign of inestimable diagnostic value. Amnesic aphasia is by far the most common form encountered. This is because there is involvement of the base of the major (usually left) temporal lobe in the posterior portion, and the lesion within the white substance is characteristic for the production of this aphasia. Anomia is the most common clinical manifestation. An extremely short memory is the basis for the defect. Alexia results when the lesion is farther toward the angular gyrus. Optic-auditory aphasia may result from interruption of the association pathways from the angular gyrus to the auditory area. True sensory aphasia of Wernicke is extremely rare in abscess of the temporal lobe. This is explained on the basis that the cortex of the superior temporal gyrus is hardly ever affected, the lesion being deeper and lower. Agnosia for taste and smell has been reported rarely. Aphasia may occur from a lesion of the minor (usually right) temporal lobe also. There are various explanations for this, but its occurrence cannot be denied. Polyphrasia has occurred in two of our cases after drainage of the abscess. Hemianopia is difficult to test for, because the severe illness of the patients and the stupor make concentration difficult, and aphasia interferes.

(*b*) Neighborhood symptoms also appear. Of the cranial nerves, the third and fifth are frequently affected. Ipsolateral mydriasis is the rule. Pain in the eye of the same side is highly characteristic when present. It may be the only symptom. Jacksonian seizures are valuable diagnostically. The face is usually most affected, and the lower extremity least. This may be due to cortical or capsular irritation. Hemiplegia is not rare. This is almost certainly of capsular origin. I have seen decerebrate rigidity in several cases from pressure of the brain stem against the tentorium. Sensory loss is not important. Conjugate deviation is not rare; when it occurs during a jacksonian seizure, it is toward the opposite side. Otherwise, in abscess of the temporal lobe the deviation is always toward the lesion.

5. Meningeal Symptoms: These are hardly ever absent in abscess of the brain. For this reason, many patients with abscess of the brain are frequently sent by the admitting intern to the ward for contagious diseases. The differentiating point is easily stated, but the necessary work is not easily carried out. The patient with a meningeal reaction from abscess of the brain may have a turbid spinal fluid, which of course contains many cells, under high pressure and even with bacteria present. The bacteria will not grow; hence the final test is culture. Only by a positive culture can meningitis be distinguished. For this reason, when a patient appears to have meningitis in the presence of otitis media, one operates as though the reaction were only meningeal. It is difficult to recognize an abscess of the brain when other complications are present, but it is not difficult to recognize the presence of a surgical intracranial complication of otitis media.

TREATMENT OF BRAIN ABSCESSES, WITH SPECIAL ATTENTION TO TEMPOROSPHENOIDAL ABSCESSES OF OTITIC ORIGIN. DR. CARL W. RAND.

I am presenting a summary of forty cases, personally observed, which were proved either at operation or by autopsy. The location and results of treatment in these forty cases are summed up as follows:

Location, Lobe	Total	Died	Recovered	Mortality, per Cent	Recovery, per Cent
Temporal	21	13	8	61.9	38.1
Frontal	15	10	5	66⅔	33⅓
Cerebellar	2	1	1	50	50
Parietal	1	1	..	100	

Multiple abscesses, right frontal, parietal and temporal lobes, 1; died, 1; mortality, 100 per cent.

Eighteen of the twenty-one abscesses of the temporal lobe were otitic in origin; one followed a compound comminuted, depressed fracture of the skull; one followed pneumonia and empyema, and one, a parietotemporal abscess, followed bronchiectasis. The cases of abscess of the frontal lobe were secondary to frontal sinusitis, at times complicated by spreading osteomyelitis of the skull. The two cerebellar abscesses were otitic in origin. The abscess of the parietal lobe was embolic from the lungs, following a tracheotomy. The case of multiple abscesses was secondary to pansinusitis.

In sixteen other cases, exploration was made for supposed abscess of the brain, no abscess being found. Of these patients, eleven died (mortality, 68.7 per cent), and five recovered (31.3 per cent). In eight of the fatal cases the patients died of meningitis, and in five postmortem examination was refused.

BOOK REVIEWS

Syphilis héréditaire du système nerveux. By L. Babonneix. Price, 60 francs. Pp. 432, with 54 figures. Paris: Masson & Cie, 1930.

This book deserves the careful consideration of members of the medical profession who have more than a passing knowledge of the subject. It gives evidence of careful thought and broad personal experience. Babonneix has collected a great many cases, many of his own and others from the experience of his associates. In his mode of presentation of the subject, Babonneix harks back to the Greek models; in the best Socratic method, he poses his questions: for example, the first heading is, "L'hérédo-syphilis nerveuse existe-t-elle?" Then follows, as it were, a debate giving first the affirmative, then the negative, followed by the author's own conclusions, which are usually quite diffident.

His attitude toward the subject of congenital syphilis and its effects is reminiscent of the attitude of the younger Fournier and Tarnowski toward third generation syphilis. The conditions that Babonneix discusses in relation to congenital syphilis include infantile hemiplegia, Little's disease, idiopathic epilepsy and convulsive states, striate syndromes, Thomsen's disease, the myopathies, tics, muscular atrophy, chorea, amyotonia, incontinence of urine, certain psychoses, endocrine syndromes and hydrocephalus. As the book deals with propositions that are by no means generally accepted, the author's material deserves careful scrutiny before one accepts his conclusions. In a considerable measure the importance of his ideas is conditioned by whether one accepts his criteria or not. Under the heading "Evidence in the Parents or Grandparents of Symptoms That One May Attribute to Syphilis," he lists: genital cicatrices, leukomelanoderma, psoriasis of the palms, leukoplakia, tabes, dementia paralytica, aortic ectasia, cancer of the tongue and pupillary abnormalities. Among "Clinical Arguments" for the presence of hereditary syphilis, he emphasizes the syphilids, perforation of the palate, dental abnormalities of several kinds, splenomegalia, anemia, coryza, congenital cardiac malformations, persistent hydrocele, induration of the testis, deafness, interstitial keratitis, Argyll Robertson pupils, osteochondritis and periostitis. As in all argumentative matters, Babonneix might well say to the reader, "If you will accept my premises, I will have no fear for the conclusions." Many of the case histories are too brief in their presentation. For instance, in some it is merely stated that the father or mother had a disorder that may have been syphilis and that the child, the patient, did not grow to normal size. On the other hand, some of the clinical material is excellently presented.

It is obvious that Babonneix tries to give a true picture of the situation, looking at both sides of the problem and answering criticisms that might arise. For example, in his chapter on endocrine dystrophies, he discusses the views of Léri, Nicolas and others, presents his own cases and in discussion indicates that he thinks that hereditary syphilis has little to do with endocrinopathy. His final summary, however, is so carefully worded that the casual reader finds it hard to know on which side of the question the author stands, because of this very care in statement and his habit of often making his most important declarations in the form of questions. For example (page 258), he says, after circumspectly differing from his colleagues: "Do we dare say, with all deference which is due to our respected masters and esteemed colleagues, that their conclusions appear to us excessive?" Nevertheless, one cannot avoid the conclusion that he is at least in part dominated by an attitude, not so uncommon among syphilologists, that syphilis can cause anything, and therefore that if the cause of a disorder is not known, it is probable that it is due to syphilis. The reviewer may take a leaf from the book and use Babonneix' method in a critical analysis.

1. Is it not a reasonable attitude to take that active syphilis of congenital origin in a child under 6 years of age should give a positive Wassermann reaction in the blood in approximately 100 per cent of the cases? A large number of Babonneix' cases do not meet this criterion.

2. Should not active hereditary syphilis of the central nervous system cause changes of the spinal fluid? No lumbar puncture is reported in many of Babonneix' cases; e. g., only in the cases of four of thirteen children with convulsions are data submitted on the cerebrospinal fluid.

3. Should not active neurosyphilis causing destructive lesions usually be progressive? Most of the neuropathic cases presented are chronic and stationary.

A chapter of seventy-two pages is given to the subject of epilepsy and convulsions; the problem is essentially whether congenital syphilis is a frequent cause of convulsive seizures, and for the answer to this question most of the material is unimportant. The real crux of the argument would seem to be related to the question of how frequently he has found congenital syphilis in cases of so-called essential epilepsy. Babonneix states that, in one hundred and twenty cases of essential epilepsy which he has studied, he has found nineteen, or 16 per cent, which he believed were due to hereditary syphilis. This is a rather high figure, but in considering its significance it must be remembered that Babonneix is well known as a syphilologist in France; he therefore probably sees a more or less selected group of patients. Further, as the abstracts of the case material indicate, many would refuse to accept his criteria as sufficient evidence of congenital syphilis.

The book is loaded with interesting case material and full of fruitful speculation. It challenges one's powers of critique; it stimulates one's thoughts; it brings to attention many of the unsettled problems of pathology and the debatable question of their relation to syphilis; it gives ample evidence of the need for further research into the problems of hereditary neurosyphilis. The book is well organized and has some good illustrations. Two of these are reproductions of portraits of deformed children who were thought to have had congenital syphilis. The one facing page 34 is a well known work of Ribera in the museum of the Louvre. The other, facing page 170, is "The Idiot" by Velasquez in the Vienna museum. At the end of each chapter is a long "bibliographie personelle," but references to other authors are scattered, few and almost exclusively French.

Ether, cocaïne, hachich, peyotl et démence précoce: Essai d'exploration pharmacodynamique du psychisme des déments précoces. By Andrée Deschamps. Price, 25 francs. Pp. 210. Paris: Les Editions Véga, 1932.

In this monograph Deschamps relates his experiences with the use of ether, cocaine, hashish and peyotl for the purpose of "exteriorizing" the internal life of the patient with chronic dementia praecox. He conducted his researches on thirty-two cases of hebephrenic catatonia, carefully excluding the paranoid-delusional types; twenty-seven of the thirty-two patients were stuporous, negativistic and totally inaccessible to ordinary clinical approach. The author reviews the psychogenic theories of dementia praecox, contrasting them with the organic theory. He concerns himself especially with the theories that deal with the analogies between schizophrenic thinking and dreams, delirium and revery. He believes that the schizophrenic patient represents a mixture of true unchangeable organic deficit reaction with a psychogenic reaction based on "reversible lesions." It is the purpose of these pharmacodynamic procedures to break down the wall which the schizophrenic patient erects against the environment and so to determine by observation of his spontaneous activity as well as by conversation the degree of reversible and irreducible changes. Deschamps used a technic of progressive dosages after the manner of C. Pascal. Sometimes the drugs were used singly, sometimes in combination. The same patients were not subjected to different medications for comparative purposes.

Only four of the thirty-two patients showed in their thinking, as exteriorized by these methods, any analogies with the mechanisms of normal dreams. Furthermore, there were fewer analogies still with the mechanisms in delirium and revery. There was shown as an outstanding feature a disorganization, a "morselling" of the personality that is not seen in dreams, delirium or revery. These are in keeping with the results found also in other types of dementia praecox that are more accessible to ordinary clinical methods. He finds the differences from dreams, delirium and revery more important than the likenesses. He concludes: "The hebephrenic dissociation is a pathologic phenomenon composed sometimes of difficulties largely dynamic — sometimes resulting from mixed lesions, modifiable and unmodifiable by pharmacodynamic excitation. The plot is made of memories and affective states more or less feeble according to the vitality of the functional dynamism; it is comparable to intellectual activity in fatigue and in overwork (strain). Patients with dementia praecox present a special sagging of the spontaneous activity, a lack of mental vigor, a type of thinking more or less reduced, warped or suppressed, which seems to render them incapable of elaborating, of pursuing, an intense subjective thought. As Senges says: 'Autism is synonymous with passive interiorization, the internal life of these patients is more automatic than voluntary. . . .' This passivity is at times a manifestation of asthenia, an element of unknown origin but often noted in dementia praecox."

In addition, the author made notes of the neurologic status throughout his experiments, and came to the following conclusions: Generally there was a reduction in the negativism paralleling the improvement in rapport. Nevertheless, sometimes catalepsy and increase of postural reflexes appeared only when rapport was best and disappeared as the rapport also vanished. He speaks of this as latent catatonia.

With the combined tests (ether, cocaine, caffeine and strychnine) Babinski's sign appeared nine times unilaterally and once bilaterally. With all methods were noted certain signs of "extrapyramidal order": cogwheel sign, exaggeration of reflexes of posture and catalepsy. He concludes: "The (catatonic) syndrome . . . corresponds to anomalies of functioning now psychical, now pyramidal, now extrapyramidal. Pharmacodynamic exploration brings about, according to the dosage and the subjects, the phenomena of excitation, which reveal a latent catatonic tendency, or the phenomena of sedation which can cause the catatonic symptoms to disappear. It should be noted that a given dose can cause at the same time the disappearance of psychic symptoms and the appearance of latent catatonic phenomena. The different regions of the cerebrum can react in a different fashion to the same dose of the toxin."

This monograph is in the best French tradition following Claude, Robin, Pascal and others; nothing new is adduced. It is the same principle as has been applied in the experiments with carbon dioxide and sodium amytal that have been so much in evidence in recent years. No contribution is made to the pharmacology of the drugs used. Loose reference is made to "excitation," "sedation" and "inhibition." Especially to be condemned is the use of the term "reversible lesion." Any one who has had much acquaintance with catatonic patients will be extremely cautious in evaluating the bursts of confidence and rapport, which the catatonic patient may show under a multitude of conditions (some with no known pharmacodynamic basis), as evidence of "reversible lesions." The unwarranted inference is also too easily made that there is a settled organic substratum if the patient cannot be moved by these methods. Even less can be said for the importance and interpretation of the "neurologic" findings. This is especially true because of the absence of definite evidence of the pharmacologic action of the drugs (and combinations) used. The reviewer thinks that "negativism" is best understood as a psychobiologic phenomenon.

The last portion of the monograph is given over to the detailed reports of the case histories. These are well done, and should be of much value for the future understanding of the phenomena under examination.

Die Schädigungen des Nervensystems durch technische Electrizität. By Dr. Friedrick Panse. Price, 14 marks. Pp. 148. Berlin: S. Karger, 1930.

This book presents a study of the effects of electric shock on the central and peripheral nervous system, based not only on cases in the author's own experience but also on cases taken from the literature. The author, an institutional physician in Berlin, had quite a few patients in his own material, who were shocked under circumstances sufficiently well known so that more or less accurate data could be obtained from the chief engineer of the Berlin Electrical Plants (Alvensleben) regarding the nature of the shocks, that is, their electrical and physical characteristics.

The cases are grouped, for purposes of study, into various classes: diseases of the spinal cord, peripheral nerves, cerebral lesions, with and without injury to the skull, and then a short section of theoretical nature is added on the cause of death.

Panse found more severe after-effects resulting from the passage of current through the spinal cord than from any other sort of shock. And perhaps this was the commonest path for the current, for it is true that when a man makes contact with electrically charged wires by touching them with both hands the current passes through the cervical cord. In most of his material, the shocks ranged from 75 to 1,000 volts. The diseases which resulted were mostly progressive atrophic paralyses, and they seemed more frequently to result from direct than from alternating current. Because of too few cases he is not able to confirm the statement of Mills and Weisenburg that repeated shocks are most likely to bring on spinal atrophy. Other spinal after-effects, such as complete transverse lesions of the cord, or Brown-Séquard paralyses are more probably due to the fall received after the shock than to the shock itself. But there are cases both in his own and in other authors' material that exhibit signs of multiple sclerosis after a severe electric shock, and he mentions that Creutzfeldt has worked up the histology in one case and found demyelinization with partial preservation of the axis cylinders. However, the author believes that many more cases are necessary before any connection between multiple sclerosis and electric shock is established. Edema, following the patterns on the skin of spinal innervation, is common after a severe shock. Sometimes telangiectatic designs are formed.

With regard to the peripheral nerves, he admits that neuritis does occur, but infrequently. There are also occasional involvements of the bones and joints, and in rare instances, such as shock by lightning, various paralyses and vague neuralgias appear.

Far less characteristic than the spinal after-effects are the cerebral lesions. Because of the initial unconsciousness that so frequently follows electric shock, Panse believes the brain to have been involved. The signs and symptoms, however, of chronic disease resulting from this early involvement of the brain are indefinite. Increased intracranial pressure resulting in optic atrophy is noted, as well as "electric cataract," occasional epilepsy, chorea and athetosis. Sometimes auditory hallucinations and loss of memory are encountered, but the entire question of electric shock without burns of the skull causing mental symptoms is doubtful.

The idea is put forward that most of these diseases, whether spinal or cerebral, are due to vasomotor disturbances and that even the hemorrhages themselves may be diapedetic, after vasomotor paralysis of the blood vessel wall. He does not favor either school on the question of whether death is due to ventricular fibrillation or to respiratory paralysis, but says that both may be brought about by a vasomotor disturbance in the brain.

The paper contributes nothing new. The author seems ultraconservative and, if anything, tries to show that there is a minimal destruction of the nervous system following electric shock. He speaks scathingly of the experimental work done in this field, but does not review the most recent and best contributions. It is a rather thorough but uninspired piece of work.