

THE CEREBRAL FORMS OF POLIOMYELITIS *

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During the first epidemic of poliomyelitis and in the recurrent outbreaks in New York and vicinity there have occurred here and there a number of cases which have been of great interest because of their close simulation of certain cerebral conditions which I shall mention later. I refer to those cases of poliomyelitis which belong more particularly to the cerebral group of this affection. Polioencephalitis or encephalitis, as it is called, was first brought into closer relationship with poliomyelitis by Medin. In the large Swedish epidemic of 1905 there were many of these cases, and Medin in his early writings insisted on the general identity of this set of cases with poliomyelitis as it was then known. His assumptions were at first disputed by men of no less genius than Hensch, who thought that Medin in describing the cerebral forms of poliomyelitis as identical with the spinal forms in etiology and pathology had rather committed an error of clinical observation and mistaken his cases for something of another character. How certain and true the original observations of Medin have been time has shown, and Harbitz and Scheele have proven beyond question that the infectious agent producing epidemic poliomyelitis may extend to any part of the cerebrospinal system, and may affect both the gray and white matter of the brain and cord. Moreover, there is in all cases of poliomyelitis a real meningitis; that is, the processes of infection expend themselves on the membranes of the brain and cord. There is an inflammation and infiltration of these structures, and from the vessels of the pia the toxic or infectious agent enters the tissues of the brain and cord, there effecting changes of greater or lesser severity. Thus the consequent symptoms will differ in sets of cases according to the localization of the inflammatory processes at play.

The cases to which I especially desire to call attention are those in which the structures of the brain, medulla and pons are affected, leaving the cord for the most part unaffected permanently. These cases have been previously described by various writers as encephalitis or polioencephalitis superior or inferior of Wernicke or of poliomyeloencephalitis of Strümpel. We may group all these descriptive clinical pictures under the entity of polioencephalitis. This would also include the pontine forms of encephalitis of Oppenheim. The general picture

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of poliomyelitis is cerebral, the symptoms are cerebral symptoms with, in certain cases, added palsies. Thus if the nuclei of the oculomotor nerves are affected we have with the cerebral symptoms an ophthalmoplegia of greater or lesser extent, identical with that which Wernicke describes as poliomyelitis superior. If the nuclei of the facial nerves are affected and the gray matter in the floor of the fourth ventricle, the cerebral symptoms are supplemented by facial palsies, and thus there is produced the picture described by Wernicke as poliomyelitis inferior. If the process extend still further down it may involve the nuclear masses of the hypoglossus and more vital nuclei, and then symptoms of paralysis identical with acute bulbar paralysis are produced. Certain it is that the forms of poliomyelitis will merge into one another. Thus, cases occur in which there are isolated palsies, such as those of the muscles, of one or other of the eyes; and then cases occur in which eye and facial nuclei (muscles) are involved, and others in which all these are affected and bulbar symptoms occur. The last group rather number the fatal cases, though I have seen a number of bulbar cases in which recovery occurred.

The cases which are limited in their extent of involvement of the ocular and facial nuclei, and which are accompanied by cerebral symptoms, are those which to me have been of greatest interest, because in such cases of poliomyelitis I have had the greatest difficulty, in the face of the cerebral symptoms, accompanied, as they were after a while, with nuclear palsies, to differentiate them from forms of meningitis either of the acute suppurative (meningococcic) variety, or the tuberculous forms of the disease. In fact, in some cases the clinical similarity of forms of poliomyelitis with forms of meningitis is so close that it is only by careful observation that we can differentiate the two, and then only with a possibility of some doubt. In order to facilitate clinical study of poliomyelitis it will be best to first draft in outline the general history of these cases.

A child in previously good health, without any marked prodromal symptoms, develops fever which may be quite high or may be moderate in degree. There may be complaint of some headache, there may be vomiting. Such a child will continue for twenty-four hours to be up and about, and after the initial period it is noted that the fever continues as does also the headache, and after a time the patient is too sick to be about, complains of a tired feeling and goes to bed. It is then noted that the sopor deepens, and then the temperature may subside to the normal or continue a little above the normal. In some cases from this time on the history is that the patient is at times delirious, irrational, complains of headache, and resents being disturbed. There is extreme hyperesthesia. Some patients complain of pain in the nape

of the neck; there is marked rigidity with the Kernig sign in the lower extremities, and signs of a mild hydrocephalus (Macewen). Such patients may have a maudlin delirium, lie crouched in bed and refuse to take food. Close examination may discover isolated ocular palsy in some cases, and this is the only objective palsy present. In other cases with palsy of some of the ocular muscles there is slight facial palsy of one or the other side, and in still other cases these palsies may be combined with a very mild weakness of one or the other upper extremity. After a week or two, the patient gradually becomes more rational, the sensorium is brighter and he begins to recognize objects and talk rationally. If during the illness the patient is caused to stand, there is noticed a very marked ataxia and vertigo, with Romberg's symptom. As convalescence is established, the ataxia is the last symptom to improve. The hydrocephalus may persist, the compromised mental capacities may not return to the absolute normal as soon as one would expect. The temperature has during the illness, directly following the period of invasion, been normal, or, in exceptional cases, there may have been a rise of 2 or 3 degrees, with a fall to the normal daily for a week or more. As the patients convalesce they are able to sit up, this not having been hitherto possible. Speech is more distinct, due to the recession of the ataxia.

This is a sketch of the common picture. When recovery is established there may remain a strabismus, or a very mild form of ataxia in the gait, an uncertainty as it were. In one or two of my cases I have seen optic neuritis, such as choked disk, in the course of the disease, and this also may retrograde, the eyesight being entirely restored. In other cases, the eyesight which has failed during the illness may progress to absolute blindness, and this in turn may slightly improve, as in one of my cases, so that after a lapse of months the eyesight may have improved from absolute blindness to the ability to distinguish gross, large objects. In another group I have seen a complete unilateral ophthalmoplegia with dilatation of the pupil of the affected eye.

I have related enough of the symptomatology of this form of encephalitis or polioencephalitis to show how close the similarity to a cerebrospinal meningitis may be, the sudden onset, the high fever, the rigidity of the neck, the headache, the Kernig, all run close to the symptom-complex of a meningitis, and yet close study will show some differences. There is in polioencephalitis a short preliminary period in which the patient, having had a high fever, continues to be about. There is also an increasing sopor which extends over days; this is quite unlike the onset of a cerebrospinal meningitis. In these two points we can sometimes differentiate between the two diseases. Here, however, the dissimilarity ceases. In a recent outbreak of polioencephalitis in Staten

Island these two points stood out quite sharply on the clinical canvas, namely, the period of a day or so of high fever in which the patients did not quite take to bed, and then the period of fever and increasing sopor with the addition of all the symptoms of true meningitis.

Another set of cases of polioencephalitis are still more perplexing, inasmuch as they closely simulate another type of meningitis, the tuberculous form. A patient having been in previous good health will develop fever with some vomiting; the fever may be low, 102 or 103 F., or high, 104 to 105 F. The fever continues for a day or more and then sopor sets in, the temperature drops to the normal, the patient becomes completely unconscious. With this unconsciousness there is marked hydrocephalus, facial palsy, ocular palsy, such as strabismus, with loss of reflex at the knee, no Kernig, and a Babinski reflex. There may be a *tâche cérébrale*. After five or seven days of illness, the picture is the exact counterpart of a tuberculous case. The patient lies absolutely flaccid; there may be but very mild rigidity of the neck, there is Cheyne-Stokes respiration, and absence of reaction to mechanical stimuli in the presence of a normal or slightly raised temperature. After a few days the patient may succumb, but in many cases may come out of the coma and regain consciousness and power in the extremities. Such cases I have seen.

In another form the patient may have had a very short period of fever, which may have come on suddenly. Then after a few days the temperature falls to the normal, but the patient is noted to be stupid, and to act as if in a trance; there is mild hydrocephalus, but the sopor is the principal symptom. A bright child is noticed to act stupidly; begs to be left alone. There is hyperesthesia. All of these are present in face of a normal temperature. Gradually the patient after two or three weeks becomes brighter, takes an interest in surroundings, and the ataxia, which in some cases amounts to absolute inability to walk, in others to staggering gait with vertigo, gradually improves. The similarity of these cases to tuberculous meningitis is exceedingly close. There is one very salient point of difference. In cases of polioencephalitis the onset is sudden. It is especially noticeable that the children have previously been in excellent health, when they are attacked by the disease within twenty-four or forty-eight hours at the most. In this respect the two maladies are far apart. In tuberculous meningitis the onset is gradual, and cases of sudden onset are extremely rare; in fact, I have not seen an authentic case in several hundreds of cases. In tuberculous meningitis there is a state of sopor in which some preservation of intelligence and of the surroundings exists, which does not last long, but will deepen into coma; whereas in polioencephalitis there is a diminution of the sopor, and finally after a week or two the patient is observed to be brighter.

CASE REPORTS

CASE 1.—L. D., male, aged 5 years, has had rachitis. Three years ago he had scarlet fever and diphtheria. The tonsils had been removed.

Family History.—This was negative.

Personal History.—Five weeks before admission to the hospital the patient was taken with high fever, headache and prostration. The fever apathy continued for two weeks, during which time the child vomited frequently. The fever then ran a lower course and the child became somewhat brighter, complained of severe headache, vomited occasionally, and was constipated. The patient complained of pain in the right eye and right hand. There had been no convulsions. The child was quiet but the parents thought it did not sleep. There was sighing respiration.

Examination.—When admitted to the hospital: The patient was soporose, although he answered questions. There was slight rigidity of the neck, and a tendency to yawn. There was some hydrocephalus on the right side. The reflexes were exaggerated; the pulse equal, regular, no paralyses noted of any kind. There was slight neck rigidity, *tâche cérébrale*, signs of hydrocephalus on both sides; later on the abdomen was retracted; *left internal strabismus*, patient stuporous but conscious when roused; no evident paralyses. A lumbar puncture yielded 30 c.c. of clear fluid under some pressure. A day subsequent to admission the patient was brighter. An examination of the fundus oculi revealed some small retinal hemorrhages suggesting compression of the cerebral retinal arteries but no choked disk.

Five days after admission patient was conscious with the above ocular palsy, but interested in his surroundings; some exaggeration of the knee-jerk. On walking the patient showed some tremors; complained of headache, was apathetic, pupils uneven, right larger than the left. Four days subsequently he was still apathetic and complained of headache.

A second lumbar puncture four days after the above entry yielded 40 c.c. of clear fluid under some pressure.

Two weeks after admission the patient was still apathetic, soporose, with neck rigidity, and showed slight flatness of the right side of the face.

The eyes examined by Dr. May at this time showed optic nerve atrophy, so-called postneuritic atrophy, with hemorrhage in the retina. The patient was brighter but there was still some neck rigidity and signs of hydrocephalus.

After four weeks the patient was able to be out of bed; there was some mental obtuseness, marked signs of hydrocephalus; no blindness. There was a distinct ataxia or cerebellar gait; mentality continued below the normal. The patient was up and about, without temperature and played with other children.

Puncture fluid examined showed no bacteria; 100 per cent. lymphocytes; some reaction for sugar and albumin.

The von Pirquet tuberculin reaction was negative; blood showed 12,000 leukocytes, with a differential count of 51 per cent. polynuclears on admission. On discharge, or near that, the count was 8,000 leukocytes.

The temperature was normal after the first twenty-four hours' stay in the hospital, with the exception of a rise in temperature, due to an injection of the serum of Flexner as a safeguard, should examination of the fluid show meningococci.

Discussion.—This is a typical case of polioencephalitis resembling very much a tuberculous form of meningitis—the slight rigidity, stupor, hydrocephalus and low leukocyte count. The history, however, showed an acute onset five weeks before admission to the hospital. The puncture fluid also showed fully 100 per cent. of lymphocytes, a fact which might very well be linked with tuberculosis. The child was discharged from

the hospital well, however, with the remains of the encephalitis in the form of hydrocephalus and impaired mentality. The only paralysis during the illness was ocular.

CASE 2.—J. C., male, aged 7½, was admitted Dec. 22, 1908.

Family History.—Negative; no tuberculosis.

Past History.—None of the exanthemata; was perfectly healthy before the present illness; no pulmonary symptoms; bowels always normal; no urinary symptoms.

Present History.—For the previous two weeks the parents had noticed that the child had not acted as he did previously; he would cry out suddenly and then laugh; was pale; had no fever; no other symptoms until three days prior to admission when he suddenly became stuporous, cried out, complained of headache. Since then the stupor had deepened, the child almost constantly moaning and crying; no convulsions.

He had slight fever, no retraction of head, no photophobia; neck was somewhat stiff; no vomiting; bowels had been obstinately constipated; did not take any nourishment; no twisting of the face, and the child did not move its right arm as well as its left; occasionally cried out at night; with grinding of the teeth.

Physical Examination.—Fairly well nourished, lay in a stuporous condition; head somewhat retracted, patient constantly sighed and moaned with grinding of his teeth; restlessness during examination; seemed unable to move the left arm and leg, respiration was very irregular; practically no rigidity of the neck; some Macewen, especially on right side of the head; *tâche* present; no Kernig, no hyperesthesia, slight photophobia. Mucous membranes normal; no ataxia; no herpes; ears negative; eyes, both upper lids somewhat ptosed, pupils equal, regular, reacted to light; eyes had a slight nystagmus-like motion; no strabismus; conjunctivæ somewhat injected; no petechia; some excoriation about the *alæ nasi*; teeth and gums in fairly good condition; sordes on lips; tongue coated. Posterior cervical and a few small axillary glands enlarged. Examination otherwise negative; chest fairly well formed; lungs negative; heart normal; action somewhat irregular and rapid; no murmurs; abdomen retracted, lax, no pain; normal; liver normal; spleen negative.

Extremities: Right arm somewhat spastic, hand held clenched, and, as noted above, the child was inclined to move left extremity more than the right; knee-jerks exaggerated. No Babinski, no ankle-clonus.

December 23 lumbar puncture; 33 c.c. of clear fluid under moderate pressure removed; tuberculin cutaneous reaction negative. White blood cells 10,000; 64 per cent. polynuclears.

December 24. General condition somewhat better; less irritable, lay in a semistuporous condition; eyes slightly rotated to the left; no rigidity of neck; no Kernig. Second tuberculin reaction negative.

December 25. Examination of the eyes negative.

December 27. General condition fair; still irritable; did not speak; rigidity of the neck; no signs of hydrocephalus; pupils equal; knee-jerks exaggerated; left tendon reflexes exaggerated; physical condition the same.

December 28. Lumbar puncture; 20 c.c. of clear fluid removed.

January 1. The patient for the previous few days had had periods of stupor and maudlin delirium, in which he cried in a low tone; did not answer questions; did not seem conscious of his surroundings; no paralysis of the extremities, with the exception of the right upper extremity, which seemed to be weaker than its fellow; patient turned his head from side to side constantly; did not take nourishment; no signs of nuclear involvement in the shape of paresis or paralysis.

January 2. Tuberculin reaction negative; general condition much improved; very noisy and delirious most of the day; had a hot bath and then became

brighter; seemed to see and hear when spoken to, but did not speak; he motioned with his hands. Very noisy the previous night; took nourishment better; lungs and eyes negative; no paralysis; moved the left arm more than the right; knee-jerks exaggerated.

January 6. The patient in the morning was conscious; sat up in bed with a meaningless smile, when he talked speech was indistinct; had a nasal timbre. Patient did anything he was told to do; had marked loss of power in upper and lower extremities; had a Romberg; when he stood or walked he staggered; his arm and fingers taking on position of athetosis; had no paralysis or paresis of facial muscles; expression of eyes rather vacant, but was conscious and brighter.

January 9. Patient much quieter and brighter, had at times an idiotic smile; speech somewhat indistinct, and had a nasal tone; slight flatness of right side of face; tongue deviated slightly to the right; pupils central—reacted to light; right grip not as strong as left; no apparent atrophy, used arm fairly well; the right leg was quite as strong as the left; knee-jerks active; otherwise negative.

January 16. Discharged well; no paralysis; bright; speech still somewhat nasal.

The temperature the first week, from December 21 to 28, ranged from 98.5 to 99.8 in the rectum. After that it remained normal for four weeks, when he was discharged.

The urine was examined three times during the stay in the hospital and was found negative. The lumbar puncture fluid was examined twice.

January 2, Cytology, 100 per cent., lymphocytes; bacteriology, negative; traces of albumin. The second specimen 50 c.c.; report of sugar reduction; 95 per cent. lymphocytes; mononuclears; no bacteria. Pathologist thought it had more the character of a transudate than an exudate.

Discussion.—In this case there is an imperfect previous history in that no sudden onset with fever was obtained, but there was a period of two weeks of mental irregularities, slight fever and increasing sopor. The patient on admission to the hospital was unconscious and delirious. This delirium was of a distinctly maudlin variety and cleared up completely, leaving a bright intellect. There was on admission, also, rigidity of the neck, vomiting and headache. There was no real paralysis or strabismus. The reflexes were increased. There were signs of internal hydrocephalus. In this case there was a distinct marked leukocytosis, 30,000, with a polynuclear blood-count of 88 per cent. The puncture fluid also showed a lymphocytosis of 100 per cent. and 95 per cent., sterile to culture; some albumin and sugar. There was during the course of the affection slight flatness of one side of the face, some slight deviation of the tongue, and a nasal timbre to the voice. The latter persisted until his discharge.

CASE 3.—J. H., aged 4½, was admitted to the service March 2, 1909.

Family History.—No tuberculosis; the stepmother had a cough and hematemesis and saw the child frequently.

Previous History.—No measles, scarlet fever, pertussis or diphtheria; at the age of 6 months the patient had pneumonia for five days.

Present Illness.—This began five weeks prior to admission with occasional vomiting, which increased in frequency until the child vomited after each meal. No vomiting occurred in the previous two weeks. At that time the child complained of headache and pain in the abdomen, and continued to complain of

headache up to admission; had marked cough for a short time two weeks prior to admission and began to be drowsy and slept a good deal of the day; was conscious and recognized mother and asked for food, and played with her toys until five days prior to admission, when she developed rigidity of the neck. For the previous five days the child had seemed to be brighter and had remained in bed, up to that time she was up and about; *she did not seem to see well*. No fever or paralysis; the bowels were constipated; history of low temperature; no febrile movement.

Physical Examination (by house physician).—General condition poor, though fairly well nourished; marked rigidity of neck with Macewen; no Kernig; *tâche cérébrale* present; patient lay in a stuporous condition; could not be roused; made motions with the hands, did not talk; no hyperacusis, no photophobia; somewhat irritable when disturbed; no eruption on the skin; the ears were negative.

Eyes.—Left pupil larger than the right; they reacted to light; conjunctivæ negative; left internal strabismus; no facial paralysis; teeth and gums in fair condition; tongue coated, moist; throat slightly red; larynx, trachea, and thyroids negative; a few axillary glands could be felt; chest fairly well formed; otherwise negative; heart negative; abdomen negative; liver also; spleen not felt; genitals negative, with slight discharge; no edema of the extremities; knee-jerks exaggerated; there was ankle-clonus on both sides; there was a Babinski on left side; no paralyses.

Synopsis.—Stupor, irritability, rigidity, Macewen, *tâche*, ankle-clonus, Babinski, exaggerated knee-jerks, left internal strabismus.

March 3. Lumbar puncture; 30 c.c. of clear fluid containing flocculi was removed. Blood examination: Leukocytes, 30,000, polynuclears 88 per cent. Fundi of eyes examined; negative.

March 5. General condition about the same, patient was in bed; stuporous, but could be roused and then was irritable; moderate retraction of head, marked rigidity of neck, Macewen, slight Kernig; *tâche* present; slight weakness of the left external rectus; no paralysis nor paresis; did not void urine; must be catheterized. Respiration cerebral; no clonus, no Babinski.

March 7. Patient was irritable when disturbed; quiet when left alone; had a Kernig, rigidity of neck, Babinski, no Macewen; cries out. Lumbar puncture; 33 c.c. of clear fluid obtained; contained flocculi.

March 10. Patient was conscious; irritable and disposed to cry; sat up in bed when not watched; noticed everything around the bed. Slight Kernig with Babinski, especially on right side; rigidity of the neck; took nourishment; fundus of the eye normal.

March 12. This a. m. the patient was noisy; had distinct retraction of head; rigidity, Kernig, Babinski, opisthotonos; no paralysis of the facial muscles; took nourishment fairly well; was conscious; pulse slow and regular. White blood cells, 12,200; polynuclears 71 per cent.

March 14. Patient was more rational; sat up in bed; no paralysis; there was slight rigidity of neck, slight Kernig, no Macewen; chest and abdomen negative; took nourishment quite well; tuberculin reaction negative.

March 15. Improvement continued; patient sat up and noticed objects; was less irritable; had slight internal strabismus on the left side.

Patient's general condition was good; was more conscious; more or less aware of surroundings, no rigidity, no Kernig, slight Macewen on left side, no paralysis of limbs. Weakness of the left internal rectus.

March 17. Patient was examined with reference to paralysis; none of the face and extremities was found; strabismus still noted.

March 28. Patient had been up and about the last week; had only a left internal strabismus left. Discharged.

During the patient's stay in the hospital the temperature ranged from 98 to 100.8 F. in the rectum during the first week, and then fell to normal; pulse and

respiration ranged from 20 to 30 for the latter to 90 to 136 for the former, the latter during the fever. When she was up and about the patient's pulse and respiration were 80 and 24 respectively.

The night nurse noted that during the first week the patient slept fairly well, but cried out at night and was restless at times; it was necessary to catheterize the patient; but after March 6 the patient, though restless, slept fairly well without any delirium. The urine examined during the patient's stay in hospital was negative.

The cerebrospinal fluid examined was negative on first puncture as to bacteria; there was a slight amount of albumin present and some sugar.

The second lumbar puncture, March 10, gave a cytology of mononuclears of 98 per cent., with no bacteria to culture or to spread; there was some albumin, 2 mg., and no sugar.

Discussion.—I saw this case in consultation. The onset was more or less acute. The subsequent history resembled a tuberculous meningitis, and the diagnosis was placed as a probable instance of this disease. In the hospital the symptoms cleared up, so that the patient, who was exceedingly bright, was up and about after two weeks. It is to be noted after discharge that though the patient's eyesight was good she returned in a month with a history of blindness of sudden onset. This, after a while, cleared up so that the patient could discern objects clearly. The fundus showed an optic atrophy. In the course of the affection there was a blood leukocytosis of 30,000, with a polynuclear count of 88 per cent. The fluids obtained by lumbar puncture gave a lymphocytic cytology of 98 per cent., some albumin, no sugar. The urine was negative; as also the lungs. Repeated von Pirquet skin tuberculin test was negative, and the temperature for the stay in the hospital did not exceed the normal after the first week. This case so closely resembled a tuberculous meningitis that a differential diagnosis without prolonged observation seemed impossible.

CASE 4.—S. F., schoolgirl, aged 11, was admitted to the hospital Feb. 8, 1909.

Family History.—Seven other children living and well. No history of tuberculosis.

Previous History.—Measles, no scarlet fever, no pertussis, no diphtheria, occasionally sore throat, no rheumatism, no pneumonia, no other complaint.

Ten days prior to admission the patient was taken ill and was in bed with high fever, vomiting, headache, malaise; then patient was up and about, but complained of occasional headache until February 7.

Present Illness.—The day before admission she had severe headache, and began to vomit; this continued until the day of admission, when she had general convulsions. Starting with a severe convulsion she had passed into a state of unconsciousness with some fever. The convulsions were repeated and back and neck became rigid; the bowels were constipated; there was no cough or vomiting on day of admission to hospital.

Physical Examination.—(By house physician.)—General condition fair; patient well nourished; slight soporose condition; patient continued to lie on the left side; conscious; irritable; there was some rigidity of the neck; marked Macewen; slight Kernig; *tâche cérébrale*. Patient could be roused from soporose condition; did not seem to be conscious, but simply moaned and cried; respiration somewhat irregular; cheeks flushed; put hands to head at times; twitching;

no retraction of the head. The skin showed some flea-bites, "*tâche bleuâtre*," no petechia; ears and mastoid negative; pupils regular; central, easily dilated; conjunctivæ injected; no paralysis; there was sordes in mouth; teeth and gums in good condition; tongue was coated and moist; throat showed muco-pus; no facial paralysis; thyroids and spine negative; few small axillary and inguinal glands to be felt; chest negative; somewhat sunken; abdomen retracted; liver, spleen and genitals negative. Extremities: Slight edema over the tibias; knee-jerks not obtained; no Babinski; no paralyses.

Synopsis.—Stupor, Macewen, Kernig, rigidity of the neck, *tâche cérébrale*.

February 9. Lumbar puncture; 35 c.c. of clear fluid removed under great pressure, and 30 c.c. of Flexner serum injected as a precaution should meningococcus be present on examination. White blood cells, 72,000; polynuclears, 79 per cent. Cutaneous tuberculin reaction negative.

February 10. Patient lay in a crouched position; was irritable when disturbed; cried out and was exceedingly hyperesthetic; retraction of head, rigidity, Kernig, as on the previous day; arms and extremities showed some edema still present; patient had ordinary redness of fauces; chest negative; patient did not take nourishment.

February 11. Patient had a general exanthematous rash (serum); patient lies in same position as on the previous day; general condition about the same; delirious when disturbed; rigidity and Kernig still present. Nurse reported that patient sat up and took notice of things.

February 12. The patient was much improved; opened her eyes and seemed to notice objects; was much clearer and did not resist quite so much. There was still very marked Kernig and very marked rigidity of the neck and retraction of head; there was also mydriasis when the head was flexed and slight strabismus on the left side.

February 13. When the patient was admitted the urine was of a distinctly brownish tint; it had now become clear but was distinctly colored; estimate of urine very difficult on account of the involuntary discharges; patient when left alone was very quiet; when interfered with still resisted; did not answer questions. Patient seemed to be more conscious, but was apparently deaf; no paralyses; Kernig still present.

White blood cells, 12,000; polynuclears, 83 per cent; fundus of the eyes normal.

February 14. Patient the previous night sat up; was quite logical, but apparently deaf; when any one came near her the patient was frightened, but was more rational than the previous day; no edema of the tibia. There was a Kernig, rigidity of the neck, no Macewen, excretions involuntary.

February 15. Patient could hear; was more rational; had external strabismus of right eye; this was noted the previous day; rigidity of neck still present; as also Kernig; had normal reflexes on both sides; some edema of the tibia.

February 16. Patient improved; more rational; Kernig and rigidity still present; the urine was normal.

February 17. Patient sat up; was quite rational; external strabismus of the right eye unchanged; Kernig still present; headache of the day before was gone.

February 19. The patient continued to improve; no apparent paralyses of the extremities; no paralysis of facial muscles.

February 22. The patient complained of lack of power of left hand; right grasp a little stronger; no limitation of motion of upper extremities; no apparent atrophy.

February 24. Slight limp in left leg, knee-jerks on left side diminished.

February 25. Patient looked bright; felt well; slight Kernig; slight weakness of left upper extremity.

March 2. Patient examined to-day; appeared bright and normal; slight loss of power in left hand; no atrophy of muscles visible in upper and lower extremities; no loss of power; no Kernig; no Babinski; no ocular or facial

paralyses. Patient had loss of power in left arm, but this was more apparent than real.

The temperature of the patient, which from admission February 8 to February 14 ranged up to 104 F., gradually fell on February 14 to 100 F.; respiration became pretty regular—from 22 to 32—and the pulse was 90 to 120. The following day the temperature, pulse and respiration were normal.

The night nurse reported that on admission and at intervals afterward the child was particularly noisy at night. During the day she was quite comfortable. The urination was almost always involuntary. She refused nourishment, was constipated up to February 12, after which time she slept at night and was quiet. The puncture fluid was reported as practically normal; there was sugar present, also traces of albumin; cytologic examination showed a few mononuclear cells. Wassermann was negative. The urine was obtained by catheter and, with the exception of a few bacterial cells, was sterile.

Examination of Urine.—February 11, hyaline and granular casts, and some blood and pus were present. February 12, about the same—blood, pus and casts. February 14, a few granular casts. February 15, no casts and no blood; negative after that time with the exception of a few leukocytes.

Discussion.—In this case the onset was acute, there then was a remission in symptoms and then the patient took to bed after a week with all the symptoms of a meningitic attack; in fact, when seen in consultation a cerebrospinal meningitis was suspected, and a puncture was made with that diagnosis in view, but the fluid obtained was clear and nothing found but a lymphocytic cytology. There was a high leukocyte count of the blood, including an excess of polynuclear cells. The illness ran the course of an acute meningitis. The finding in the urine corresponds to that of Wickman in one of his cases. Inasmuch as the urine cleared up completely, it must be surmised that the nephritis was only part of a general infection. The patient fully recovered, with a strabismus due to ocular palsy remaining with slight weakness in the left upper extremity. This, I think, is a case of acute polio-encephalitis with a meningitic onset, its course closely simulating cerebrospinal meningitis of the epidemic type. The patient was not discharged until she had absolutely recovered.

CASE 5.—Female, aged 5, was admitted Oct. 14, 1909.

Family History.—Father suffered from pulmonary tuberculosis; mother and nine other children healthy.

Previous History.—The patient was born at full term; no instruments used; measles at 2½ years; no complications; whooping-cough just previous to measles. The patient had a moderate dry cough since having measles up to one year prior to admission. No convulsions, no ear symptoms, bowels regular, urination normal. About sixteen months before admission the patient was operated on for acute appendicitis; ill five weeks; healthy since until present illness.

Present Illness.—Present illness began four days prior to admission, when the mother noticed that the child became drowsy, lost interest in her surroundings and developed moderate fever. The next day the child vomited for the first time. The vomitus consisted at first of undigested food; later of small amounts of bile-stained fluid, accompanied by much retching; vomited since, chiefly after taking food.

Since the onset the bowels were obstinately costive; no marked abdominal distension, no blood or mucus in stool. Drowsiness became intensified; child

would start in her sleep with a shriek; sighed considerably. The day before admission the child complained of pain in back of neck, developed some rigidity and became delirious and irrational; no convulsions, no palsies, slight dry cough, no dyspnea; marked prostration; drowsy; responded when disturbed; was irrational and delirious; respiration irregular; no head retraction; neck was rigid; general hyperesthesia; Macewen present, especially on left side; marked photophobia. Eyes, ears and mastoids normal; skin showed scar of operation; *tâche cérébrale* present; scattered papular spots; a few small lymph-nodes in left axilla; tongue, dry and coated; throat, teeth and gums in good condition; chest well formed; lungs clear; heart borders normal; action regular, rapid, of poor force, sounds clear, no murmurs; pulses equal, regular, rapid, small.

Liver and spleen not enlarged; abdomen lax; reflexes present.

Extremities.—Kernig's sign present on left side; left, Babinski at times.

Synopsis.—Fever, drowsiness, delirium, hyperesthesia, rigidity of neck, Macewen, left Kernig.

Blood Count.—White blood cells, 21,000; polynuclears 61 per cent.; small lymphocytes 28 per cent.; large lymphocytes 11 per cent.

October 15. Lumbar puncture; 24 c.c. clear, colorless fluid under increased tension withdrawn.

October 16. This morning patient was semiconscious; roused when talked to; athetosis in hand; dry, coated tongue; talks with lisp; slight flatness of left side of face; Kernig on both sides; marked rigidity and tenderness of neck; slight Macewen on left side.

October 17. Lungs negative; paresis of left side of face more marked; marked rigidity of neck; marked Kernig on both sides; fundus examination of eyes was negative; patient semiconscious. Von Pirquet positive.

October 18. More conscious; Kernig; Macewen very slight on left side; slight internal rotation of left eye; marked neck rigidity.

October 23. Von Pirquet still evident; Kernig, left facial flatness; bromic eruption on legs; could sit up; rigidity of neck almost gone; tongue moist; Macewen not elicited.

October 25. Sat up; left side of face still slightly flat; neck supple; Kernig, 30 degrees on both sides.

October 24. Urine amber, acid, specific gravity 12, albumin 0; a few white blood cells.

November 4. Urine amber, acid, specific gravity 24, albumin 0; a few white blood cells.

October 15. Cerebrospinal fluid showed lymphocytes 100 per cent.; negative for bacteria; no growths; no tuberculosis; albumin .5 mm.; sugar reducing substance present; Widal negative 1 to 20, 1 to 50; also on October 18.

October 14. Temperature 104.2 F. on admission; dropped to 100.8 F. on following day; and on sixteenth reached 99 F.; slight rises to 100 F. afterward. Pulse 116 on admission, respiration 28. Weight 45¾ pounds.

Discussion.—This patient, 5 years of age, was attacked more or less acutely with high fever and vomiting, passed into a condition of sopor which became intensified after a few days. There was the picture of meningitis with fever, drowsiness, delirium, apathy, vomiting, constipation, pain in neck and rigidity of the neck. What was especially disquieting was a positive von Pirquet cutaneous reaction to tuberculin, which misled into the diagnosis of tuberculous meningitis. The subsequent complete recovery disproved this, leaving us to infer a latent glandular tuberculosis. The fluid obtained by lumbar puncture showed nothing more than a marked lymphocytosis.

The recovery of this patient was complete, there being left only a slight facial flatness; no real paralysis. The temperature after the first day following admission to the hospital was normal; the urine was normal; the fundus oculi was normal.

CASE 6.—This case resembles a case I saw recently in consultation, a girl of 13. The girl was seen by several physicians, all being quite positive in the diagnosis of tuberculous meningitis. This girl like the case I am to depict recovered, with the exception that she did not, as in this case, yield a positive tuberculin reaction.

History.—The patient was a boy, aged 4, admitted to my hospital service. He had had measles, scarlet fever and diphtheria.

Present Illness.—This began three weeks before with an attack of fever and vomiting and headache; following this the boy became drowsy, did not notice and was soporose and stupid. The condition of drowsiness became more and more marked, and in this condition he was brought to the hospital. The patient was well nourished, had some slight hydrocephalus, staggered when upright, swayed especially to the left when he walked and threatened to fall. The patient was in a trance-like state and sat up in bed staring ahead; he slept well. The examination of the fundus oculi was negative.

The patient's urine at first contained acetone, diacetic acid and a trace of sugar. These disappeared in the first two days of the hospital stay. After three weeks of illness the above symptoms cleared and the patient was well. There was from the first a positive tuberculin skin reaction (von Pirquet). No lumbar puncture was made. This case differs from that of the girl I just mentioned, inasmuch as the latter had no tuberculin reaction and was unable to sit up or stand without experiencing marked vertigo. The girl was highly hyperesthetic, whereas this symptom was absent in the boy.

CASE 7.—C. R., aged 5½, was admitted Jan. 10, 1911.

Family History.—Negative.

Previous History.—Had pneumonia and measles one year ago; no other diseases. The child was perfectly well until thirteen days before admission.

Present Illness.—This began thirteen days previously with vomiting and headache. The child vomited one to three times practically every day since onset; vomiting was not projectile in character, having no relation to meals. Headache had been frontal in location and almost constant in character; had slight fever following the onset; for a week had occasional cough, with slight mucopurulent expectorations. For two days the father noticed that the child had been drowsy most of the time, and was rather irritable when awakened. There were no disturbances of the special senses; no paralyses noted; no ear disturbances; bowels fairly regular; urination normal; appetite poor; no symptoms of cardiac or renal disturbances.

Synopsis.—Vomiting and headache for three days, slight fever, slight cough; drowsiness for two days.

Physical Examination.—General condition good; well nourished; irritable. Head—no rigidity, no Macewen. Eyes—pupils equal; react to light and dilate, no palsies. Ears and mastoid negative. Mouth and teeth—several upper teeth missing; otherwise in fair condition; tongue moist and coated; throat congested. Glands and skin negative; chest well formed, expansion good; lungs negative; heart, regular, good force, no murmurs; liver—fifth space, sixth rib to free border; not felt; spleen not felt. Abdomen held tense; tympanitic; no masses; abdominal reflexes not obtained; slight *tâche*.

Extremities.—Knee-jerks much exaggerated; no Kernig, no clonus; Babinski and Oppenheim, bilateral; patella-jerk bilateral; tremor of upper extremities.

Genitals.—Some reddening of vulva; no discharge. Rectal examination not made.

Synopsis.—Irritability, exaggerated knee-jerks, Babinski, Oppenheim, tremor of upper extremities.

January 11. White blood cells 31,200; polynuclears 80 per cent.; lymphocytes 18 per cent.; large mononuclears 1 per cent; basophils 1 per cent.

January 12. Ears negative. Lumbar puncture made; about 30 c.c. of clear fluid and flakes withdrawn.

January 13. White blood cells 21,200; polynuclears 80 per cent.; lymphocytes 14 per cent.; large mononuclears 5 per cent; eosinophils 1 per cent.

January 16. General condition better; child brighter; slight rigidity of neck persists; no Kernig.

January 22. Inner reflexes present; child will not stand; eyes closed; uncertain gait present.

January 24. Child had been picking up but complained of pain in extremities; reflexes increased; Kernig present; resents interference; no pain in back; no headache.

White blood cells 10,600; polynuclears 73 per cent; small mononuclears 26 per cent.; large mononuclears 1 per cent.

February 7. Patient up and about ward.

The temperature during the first week of the hospital stay ranged from 99 to 101 F. and then dropped to the normal.

Urine during stay in hospital at only one time showed a few hyalin casts.

The fluid obtained by lumbar puncture contained 90 per cent. lymphocytes and 10 per cent. polynuclear cells. Smears and culture negative as to bacteria; sugar, moderate reduction; some albumin.

Discussion.—The onset was sudden, with headache and vomiting daily, slight fever with cough, and after ten days, increasing sopor and irritability. On admission to the hospital there were no palsies, but there was the mental irritability, exaggerated reflexes with tremors of the extremities. The blood showed during the illness a marked polynuclear leukocytosis with a lymphocytic picture in the spinal puncture fluid.

I have thus described a condition which is of great interest. It is apt to be, and is constantly, mistaken for meningitis of the cerebrospinal, acute suppurative or subacute tuberculous form. The onset of the illness is acute; it begins with a previous history of absolute health. After the acute symptoms set in there may be in some cases an abatement and then a recurrence of symptoms of a cerebral nature, which gradually deepen. If the case is one resembling an acute meningitis, the symptoms are more active, with neck rigidity, pain in the neck, headache and delirium. If the case resembles the tuberculous form of meningitis, the patient lies more quietly, exhibits palsies of the cranial nerves, and may even have marked hydrocephalus with distinct Cheyne-Stokes respiration and unconsciousness. In both sets of cases the delirium, sopor or coma lightens, the patients after a week or more of illness become brighter, and recovery proceeds. Lumbar puncture in all the cases reveals a clear or slightly flocculent fluid, without bacteria, and a cytology of 90 per

cent. to 100 per cent. lymphocytes. An examination of the blood shows at first a leukocytosis of pronounced degree of the polynuclear type.

The onset of the disease may be ushered in by fever, which rapidly subsides to within a fraction of a degree of the normal and the major part of the illness runs its course with this temperature, which is practically normal. The diagnosis is made from the points of clinical course laid down in this paper. The prognosis is for the most part good, except in those cases which involve the nuclei of the nerves controlling respiration. In such cases the outlook is that of an acute bulbar paralysis, when the extent of the lesion will decide the fate of the case. The main point is to have in mind the great similarity of a certain set of these cases to those of tuberculous meningitis, and acute cerebrospinal meningitis, and the absolute futility of a positive diagnosis without study of the case, lumbar puncture and all the clinical aids at our command.

The fatal cases of the cerebral forms of polioencephalitis have been mentioned in this paper. I have two cases of this kind to report, in one of which autopsy was performed and the diagnosis of polioencephalitis confirmed. These cases may be of sudden onset with cerebral symptoms, and a rapid involvement of the bulbar nuclei. The result is a picture of acute bulbar paralysis with cerebral onset. In some cases the onset may be gradual, in others acute. The paralysis involves the muscles of deglutition and phonation and this is the first sign of bulbar involvement of a serious nature. In these cases the ocular and facial nuclei may be involved, and as the process spreads down there is a complete paralysis of a descending type, involving the muscles of respiration. In one of the cases the respirations seemed to cease first while the heart continued beating. All cases here recorded were fatal cases, but this must in no way be assumed to be always the case, because I have seen a few bulbar cases recover, one notably in a child 3 years of age, in which the respiration was involved, as was also deglutition. In this case a complete recovery occurred.

CASE 8.—A. B., male, aged 5, was admitted Oct. 4, 1908.

Family History.—Father had tuberculosis in 1905 when at Bedford Station; since then was well. He had lost 5 pounds in the previous few weeks. The mother and two other children were well.

Previous History.—The patient had measles two years ago; otherwise no illnesses; bowels always regular; appetite good; mentally bright; never complained of headache; eyes and ears good; no eruptions on skin.

Present Illness.—Onset one and one-half weeks prior to admission, with indefinite symptoms. It was noted that the child was weak and lackadaisical; did not complain of headache; had no convulsion or palsies; had some fever; appetite was good; child slept uneasily at night and cried out in sleep; bowels regular; in the previous four days the child began to cough when talking; had difficulty in swallowing; regurgitation and coughing back food mixed with mucus; had been unable to talk in this time; unable to sit up or walk; ears and eyes remain functionally unaffected; complained of slight pain over heart; cried out frequently in sleep and had involuntary movements of arm.

Physical Examination.—General condition fair; patient well nourished; lay in an apathetic condition; cheeks flushed; moderate dyspnea; child was hoarse; marked gurgling in throat; alæ nasi dilate with each inspiration; child responds when spoken to; voice thick and husky; moderate rigidity of neck; on bending neck child was irritated; Macewen on left side; no irregularity of skull; no definite tenderness made out; no retraction of head; child somewhat irritable; Kernig; *tâche cérébrale* present; moves arms and lower extremities, but acts as if in trance; answers monosyllabic.

Skin and mucous membranes had a good color; ears and mastoids externally negative; moderate amount of cerumen in canal; eyes and upper lids somewhat closed so that upper one-half of pupil was covered. This could be overcome and child raised lid in normal manner. Pupils: right slightly larger than left, regular, central moderately dilated; reacted somewhat sluggishly to light and accommodation; weakness of both external recti; conjunctivæ negative. Nose—evidences of slight secretion ali nasi; otherwise negative. Face—left-sided facial paresis. Mouth, teeth and gums in poor condition; tongue thickly coated and moist; tonsils hypertrophied. Throat—uvula elongated; throat slightly ingested; palate moves slightly. Larynx, trachea, thyroid, spine, bones and joints negative; a few small cervical and inguinal glands were palpable.

Chest was well formed and symmetrical; right chest seemed to expand slightly more than left; no retraction.

Lungs: Anteriorly there was some dulness over the right axilla; marked bronchial râles over entire chest; breathing over anterior chest was exaggerated; numerous loud gurgling râles and expirations which seem to be transmitted from trachea. In the right axilla there were a few mucus râles on inspiration; posteriorly there was dulness at right apex down to about two fingers below spine; dulness at left apex of similar extent; over entire chest posteriorly there were numerous bubbling râles on inspiration and expiration; most marked at left base; breathing harsh and exaggerated; no change in voice.

Heart: Right border at right border of sternum; left border in nipple line; visible beat at fourth rib; apex neither seen nor felt; sounds clear; no murmurs; action regular; good force; somewhat accelerated.

Abdomen: Somewhat retracted and lax; no pain or tenderness. Liver, fifth rib to sixth rib; free border not felt; spleen not felt.

Extremities: Upper, grips seem to be equal; child seems to use left hand more than right, although both can be used fairly well; right arm weaker than left; no impairment on passive motion; no atrophies; arm reflexes present. Lower slight edema; knee-jerk not obtained; no clonus; no Babinski; no paresis or paralysis of legs.

Genitals: Double cryptorchidism. Rectal examination not made.

Blood: Leukocytes 25,000.

October 15. Eyes examined and found negative.

The child's condition remained about the same; lay quietly, preferably on the right side; child gets frequent attacks of dyspnea, which were accompanied by loud breathing; on auscultation there were found numerous moist gurgling râles throughout the chest; child takes nourishment very poorly, owing to the difficulty which it has in swallowing; reflexes in extremities gone.

October 16. Condition remained the same; lay quietly; eyes half open; had some photophobia and could see objects readily; had slight weakness of the external and internal recti muscles of the eyes; could not swallow; regurgitated all food given by gavage; breathing remained the same; signs of pulmonary edema came on frequently and cleared up in a large measure after hyperdermic injection of atropin. It was necessary to resort to rectal feeding. Lower extremities had no reflexes; abdominal reflexes also gone; there was no Kernig; electrical reactions and sensations not yet tested.

Blood: Leukocytes 33,000.

Urine: Hyalin casts; few granular casts.

The patient died with signs of respiratory failure. Postmortem made.

CASE 9.—G. R., female, admitted November 4, 1910.

Family History.—Seven other children, all well; father coughs; no tuberculosis.

Previous History.—The patient had measles; no other disease; no cardiac, pulmonary or renal disease, no rheumatism. Previous to present illness the child was perfectly well and played about in the street.

Present History.—At 5 o'clock a. m. on the morning of admission the child had involuntary urination while in bed; on taking her up she squirmed about and screamed; it was then noticed that the child could not articulate and could not stand on its feet; vomited once in the morning, and whenever she was given anything to eat; appeared to have some difficulty in swallowing; all day the child lay quietly in bed without moving a limb; had no fever.

Physical Examination.—General condition good; patient well nourished; flushed facies; markedly apathetic; somewhat stuporose; respiration somewhat rapid and regular; does not cry nor give response to spoken language; neck, no rigidity, no mastoid; Macewen present; distinct flatness of right side of face; right palpebral fissure not completely closed; mouth drawn to the left.

Eyes: Pupils equal, central and regular; mucoid discharge from conjunctivæ; no corneal anesthesia; no petechia or palsies; dry crusting of nose; lips of good color; tongue somewhat coated; gums in good conditions; teeth in good condition; pharynx negative; palate, slight deviation to left; moves actively; skin, clear, good color; one or two small healing scars.

Glands: Submaxillary, post cervical, chains.

Chest: Well shaped; lungs, negative; heart, borders not enlarged; apex, fourth space within nipple line; action rapid and regular; pulse, equal, regular, rapid.

Abdomen: Negative; liver, fourth to sixth ribs; spleen not felt.

General: Patient unable to hold back up; head falls weakly to side; weakness of right side of body complete; right arm useless; left knee-jerk just present; left arm tendon reflex exaggerated; right knee reflex elicited with difficulty; right arm completely relaxed; apparently no power; slight redness of vulva.

November 6. Patient in a condition of apathy; the Macewen still quite marked, more so than the previous day; right facial paralysis marked; a little weakness of external rectus of right side; complete right hemiplegia; knee-jerks absent on paralyzed side; present on left side; considerable atrophy of the right deltoid, biceps and triceps; sighing respiration; *reaction of von Pirquet 2 mm. positive*; slow, forcible heart action; child vomited once; constipation present; swallowed with difficulty; refused nourishment; did not talk; a little lagophthalmus of right eye.

November 4. Von Pirquet; white blood cells 17,600; polynuclears 82 per cent.; small lymphocytes 16 per cent.; small mononuclears 2 per cent.

There was a slight difference in size of the thighs, the affected being smaller; exaggerated reflex of left affected extremity; only occasionally obtainable on right side; weakness of the muscles of the neck; head fell back; child could sit up.

November 6. Right knee-jerk this morning easily obtainable; left knee-jerk elicited with difficulty; left triceps-jerk exaggerated; right not obtained.

November 7. Heart continued beating after respiration ceased. Temperature ranged from 100 to 104.8 F.; at death 102.5 F.; pulse 96 to 130; respiration 24 to 36.

Fluid obtained by lumbar puncture: First puncture had lymphocytes too few to count; no bacteria; animal inoculated. Second puncture: Cytology, 72 per cent. lymphocytes, polynuclears 28 per cent.; negative to bacteria; albumin 1 mm.; sugar, slight reduction.

Blood culture, negative.

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