Progressive bulbar paralysis is an incurable affection. Transient improvement may occur. Strychnine may be tried. Electricity is of doubtful benefit. Special care must be taken in feeding these patients, and when deglutition becomes much impaired the stomach-tube should be employed.

III. DISEASES OF THE BRAIN.

I. AFFECTIONS OF THE MENINGES.

Diseases of the Dura Mater (*Pachymeningitis*).

(*a*) **Pachymeningitis Externa.**—Hæmorrhage often occurs as a result of fracture. Inflammation of the external layer of the dura is rare. Caries of the bone, either extension from middle-ear disease or due to syphilis, is the principal cause. In the syphilitic cases there may be a great thickening of the inner table and a large collection of pus between the dura and the bone. In a remarkable case of this kind at the Montreal General Hospital the frontal lobes were so compressed by the thickened skull, and the purulent effusion between the bone and the dura, that the anterior vertical measurement of the brain was only 2·5 cm., while that of the posterior part was 8 cm.

Occasionally the pus is infiltrated between the two layers of the dura mater or may extend through and cause a dura-arachnitis.

The symptoms of external pachymeningitis are indefinite. In the syphilitic cases there may be a small sinus communicating with the exterior. Compression symptoms may occur with or without paralysis.

(*b*) **Pachymeningitis Interna.**—This occurs in three forms: (1) Pseudo-membranous, (2) purulent, and (3) hæmorrhagic. The first two are unimportant. Pseudo-membranous inflammation of the lining membrane of the dura is not usually recognized, but a most characteristic example of it came under my observation as a secondary process in pneumonia. Purulent pachymeningitis may follow an injury, but is more commonly the result of extension from inflammation of the pia. It is remarkable how rarely pus is found between the dura and arachnoid membranes.

Hæmorrhagic Pachymeningitis (*Hæmatoma of the Dura Mater*).

This remarkable condition, first described by Virchow, is very rare in general medical practice. During ten years no instance of it came under my observation at the Montreal General Hospital. On the other hand, in the post-mortem room of the Philadelphia Hospital, which received material from a large almshouse and asylum, the cases were not uncommon, and within three months I saw four characteristic examples, three of which came from the medical wards. On the other hand, the frequency

of the condition in asylum work may be gathered from the fact that Wigglesworth found 42 examples in a series of 400 unselected post-mortem examinations.

The disease is found chiefly in males and in persons over fifty years of age. It is most frequent in forms of chronic insanity and in chronic alcoholism. It has also been found in profound anæmia and other blood conditions, and is said to have followed certain of the acute fevers.

The morbid anatomy is interesting. Virchow's view that the delicate vascular membrane precedes the hæmorrhage is undoubtedly correct. Practically we see one of three conditions in these cases: (*a*) Subdural vascular membranes, often of extreme delicacy; (*b*) simple subdural hæmorrhage; (*c*) combination of the two, vascular membrane and blood-clot. Certainly the vascular membrane may exist without a trace of hæmorrhage—simply a fibrous sheet of varying thickness, permeated with large vessels, which may form beautiful arborescent tufts. On the other hand, there are instances in which the subdural hæmorrhage is found alone—in 15 out of Wigglesworth's 42 cases—but it is possible that in some of these at least the hæmorrhage may have destroyed all trace of the vascular membrane. In some cases a series of laminated clots are found, forming a layer from 3 to 5 mm. in thickness. Cysts may occur within this membrane. The source of the hæmorrhage is probably the dural vessels. Hugenin and others hold that the bleeding comes from the vessels of the pia mater, but certainly in the early stage of the condition there is no evidence of this; on the other hand, the highly vascular subdural membrane may be seen covered with the thinnest possible sheeting of clot, which has evidently come from the dura. The subdural hæmorrhage is usually associated with atrophy of the convolutions, and it is held that this is one reason why it is so common in the insane; but there must be some other factor than atrophy, or we should meet with it in phthisis and various cachectic conditions in which the cerebral wasting is as common and almost as marked as in cases of insanity.

The symptoms are indefinite, and the diagnosis cannot be made with certainty. Headache has been a prominent symptom in some cases, and when the condition exists on one side there may be hemiplegia. Extensive bilateral disease may exist without any symptoms whatever.

Diseases of the Pia Mater.

(*a*) **Acute Leptomeningitis.**—In this form the exudation is between the pia and the arachnoid membranes.

Etiology.—Acute inflammation of the pia mater occurs under the following circumstances: (1) As a result of an eruption of tubercles, most frequently in the basal meninges, forming the basilar or tuberculous meningitis which has been already considered (see tuberculosis). (2) In the epidemic cerebro-spinal fever. (3) Secondary to acute general diseases,

more particularly pneumonia, less frequently small-pox, typhoid fever, rheumatic fever, whooping cough, scarlet fever, and measles. In erysipelas meningitis may arise either by infection through the blood or by direct extension. Cases in which the inflammation passes through the bone are extremely rare; on the other hand, there are instances of extensive erysipelas of the face in which the disease travels along the nerve-roots and so reaches the meninges. In this group pneumonia is the only disease which is frequently followed by meningitis. In one hundred autopsies at the Montreal General Hospital in pneumonia, meningitis was found eight times, and I had several opportunities of seeing cases of similar character in Philadelphia. In septicæmia and pyæmia, including ulcerative endocarditis in this category, acute meningitis is not very rare. In ulcerative endocarditis it is common, as may be judged from the statistics which I collected of 209 cases, of which 25 were complicated with meningitis. No instance has fallen under my observation in connection with typhoid fever or rheumatic fever.

(4) Injury or disease of the bones of the skull, perforating wounds of the orbit, or as a sequence of abscess which is the result of injury. Under this section by far the most frequent cause is necrosis in the petrous portion of the temporal bone, which may excite either extensive inflammation of the pia mater or abscess of the brain. (5) In certain constitutional conditions, such as gout and Bright's disease. This form is usually basilar and comes on insidiously. Gout is usually mentioned as a cause of meningitis, but it must be extremely rare. Duckworth does not refer to it in his work, and the symptoms of the so-called cerebral gout can scarcely be separated from those of uræmia. On the other hand, in Bright's disease, I have met with at least three instances of well-marked meningitis, chiefly of the base.

(6) While in a great majority of all cases of basilar meningitis in children tubercles may be found, a simple *leptomeningitis infantum* must also be recognized. Cases are not very uncommon. Two occurred in debilitated children under my care at the Infants' Home in Montreal, and I saw at least two specimens of the kind at the Philadelphia Hospital. The condition may be limited to the meninges at the base, particularly at the posterior part, and to the under surface of the cerebellum. It has also been termed occlusive meningitis, owing to the fact that involving chiefly the posterior portion of the meninges about the cerebellum and medulla, the foramen of Magendie may be closed, with the result of acute, sometimes purulent hydrocephalus, as described by Gee and Barlow.* (7) Other causes mentioned are sun-stroke and excessive study, which are probably doubtful. Syphilis, which is a common cause of chronic meningitis, rarely induces the acute form.

Morbid Anatomy.—The basal or cortical meninges may be involved. In the form associated with pneumonia and ulcerative endocarditis the

* On the Cervical Opisthotonos of Infants, St. Bartholomew's Hospital Reports, 1878.

disease is bilateral and usually limited to the cortex. In extension from disease of the ear it is usually unilateral and may be accompanied with abscess or with thrombosis of the sinuses. In the non-tuberculous form in children, in the meningitis of chronic Bright's disease, and in cachectic conditions the base is usually involved. The vessels are injected, the subarachnoid fluid is increased and becomes opaque. The arachnoid is also turbid, and there may be a yellowish-white, creamy exudate, or a grayish-green purulent matter beneath the arachnoid. The interpeduncular space may be completely filled with the exudate, which extends upon the under surface of the cerebellum. In the cases secondary to pneumonia the effusion beneath the arachnoid may be very thick and purulent, completely hiding the convolutions. The ventricles also may be involved, though in these simple forms they rarely present the distention and softening which is so frequent in the tuberculous meningitis.

The *leptomeningitis infantum* may present a picture very similar to the tuberculous disease. There is exudation about the optic chiasma and in the Sylvian fissures and toward the cerebellum. In some instances we can say definitely that the condition is not tuberculous only after the most careful search in the meninges and central arteries, and when no tubercles are found in the lungs and bronchial glands. In other instances the meningitis may be limited to the posterior part of the base, about the pons, cerebellum, and fourth ventricle, and the lateral ventricles may present a most remarkable ependymitis. In a specimen recently shown to me by W. T. Howard, Jr., from a child aged three months (which had had an operation performed for imperforate anus), there was posterior basilar meningitis, the fourth ventricle was filled with pus, the walls thickened, rough, and infiltrated with pus; the lateral ventricles were enormously distended with pus, and the ependyma, which was from two to three millimetres in diameter, was softened and in a condition of purulent infiltration. A coccus and the *bacterium coli commune* were found in the pus. In a somewhat similar case at the Philadelphia Hospital the ependymitis was limited to the posterior and descending cornua, which were greatly distended and contained pus. The anterior cornua were little, if at all, affected, owing doubtless to the influence of gravity. This condition of intense purulent ependymitis is rare in the adult, but I remember to have seen an instance of it in a patient of Pepper's at the University Hospital, Philadelphia.

Symptoms.—I have already spoken at length of the clinical features of tuberculous meningitis, which is by far the most common and important form. The other varieties have a general resemblance to it, particularly those in which the base is affected. I have already, on several occasions, called attention to the fact that cortical meningitis is not to be recognized by any symptoms or set of symptoms from a condition which may be produced by the poison of many of the specific fevers. In the cases of so-called cerebral pneumonia, unless the base is involved and the

nerves affected, the disease is unrecognizable, since identical symptoms may be produced by intense engorgement of the meninges. In typhoid fever, in which meningitis is very rare, the twitchings, spasms, and retractions of the neck are almost invariably associated with cerebro-spinal congestion, not with meningitis.

A knowledge of the etiology gives a very important clew. Thus, in middle-ear disease the development of high fever, delirium, vomiting, convulsions, and retraction of the head and neck would be extremely suggestive of meningitis or abscess. Headache, which may be severe and continuous, is the most common symptom. In the fevers, particularly in pneumonia, there may be no complaint of headache. Delirium is frequently early, and is most marked when the fever is high. Convulsions are less common in simple than in tuberculous meningitis. They were not present in a single instance in the cases which I have seen in pneumonia, ulcerative endocarditis, or septicæmia. In the simple meningitis of children they may occur. Rigidity and spasm or twitchings of the muscles are more common. Stiffness and retraction of the muscles of the neck are important symptoms; but they are by no means constant, and are most frequent when the inflammation extends to the meninges of the cervical cord. Vomiting is a common symptom in the early stages, particularly in basilar meningitis. Constipation is usually present. Optic neuritis is rare in the meningitis of the cortex, but is not uncommon when the base is involved.

Important symptoms are due to lesions of the nerves at the base. Strabismus or ptosis may occur. The facial nerve may be involved, producing slight paralysis, or there may be damage to the fifth nerve, producing anæsthesia and, if the Gasserian ganglion is affected, trophic changes in the cornea. The pupils are at first contracted, subsequently dilated, and perhaps unequal.

Fever is present, moderate in grade, rarely rising above 103°. In the non-tuberculous leptomeningitis of debilitated children and in Bright's disease there may be little or no fever. The pulse may be increased in frequency at first and subsequently is slow and irregular.

Treatment.—There are no remedies which in any way control the course of acute meningitis. An ice-bag should be applied to the head and, if the subject is young and full-blooded, general or local depletion may be practised. Absolute rest and quiet should be enjoined. When disease of the ear is present, a surgeon should be early called in consultation, and if there are symptoms of meningo-encephalitis which can in any way be localized trephining should be practised. An occasional saline purge will do more to relieve the congestion than blisters and local depletion. I have no belief whatever in the efficacy of counter-irritation to the back of the neck, and to apply a blister to a patient suffering with agonizing headache in meningitis is needlessly to add to the suffering. If counter-irritation is deemed essential, the thermo-cautery, lightly applied, is more satisfactory, because the pain inflicted is transient.

The gastro-intestinal symptoms should receive appropriate treatment. Gowers states that in two instances of septic meningitis which recovered the good effects seemed to be due to large doses of the perchloride of iron. Iodide of potassium and mercury are recommended by some authors.

The application of an ice-cap, attention to the bowels and stomach, and keeping the fever at a moderate height by sponging, are the necessary measures in a disease recognized as almost invariably fatal, and in which the cases of recovery are extremely doubtful.

(*b*) *Chronic Leptomeningitis.*—This is rarely seen apart from syphilis or tuberculosis, in which the meningitis is associated with the growth of the granulomata in the meninges and about the vessels. The symptoms in such cases are extremely variable, depending entirely upon the situation of the growth. They may closely resemble those of tumor and be associated with localized convulsions. The leptomeningitis infantum may be chronic. In the cases reported by Gee and Barlow the duration in some instances extended even to a year and a half. The involvement of the posterior part of the meninges and of the ventricles may lead to dilatation and hydrocephalus. The symptoms upon which these authors lay stress are convulsions, and retraction of the head, which is particularly marked when the child is made to sit up. There may be rigidity of the limbs and epileptiform convulsions.

II. AFFECTIONS OF THE BLOOD-VESSELS.

Hyperæmia.

Congestion of the brain has played an important part in cerebral pathology. Undoubtedly there are great variations in the amount of blood in the cerebral vessels; this is universally conceded, but how far these changes are associated with a definite group of symptoms is not quite so clear. The hyperæmia may be either active or passive.

Active hyperæmia is associated with febrile conditions, with increased action of the heart, chilling of the surface, contraction of the superficial vessels, and with the suppression of certain customary discharges. Among other recognized causes are plethora, functional irritation, such as is associated with excessive brain work, and the action of certain substances, such as alcohol and nitrite of amyl.

Passive hyperæmia results from obstruction in the cerebral sinuses and veins, engorgement in the lesser circulation, as in mitral stenosis, emphysema, from pressure on the superior cava by aneurisms and tumors, and in the venous engorgement which takes place in prolonged straining