the constant worry and the sleepless nights, that the danger of contracting the morphia habit is very great. On no consideration should the patient be permitted to use the hypodermic needle himself. It is remarkable how promptly, in some cases, the injection of distilled water into the nerve will relieve the pain. Acupuncture may also be tried; the needles should be thrust deeply into the most painful spot for a distance of about two inches, and left for from fifteen to twenty minutes. The injection of chloroform into the nerve has also been recommended.

Electricity is an uncertain remedy. Sometimes it gives prompt relief; in other cases it may be used for weeks without the slightest benefit. It is most serviceable in the chronic cases in which there is wasting of the legs, and should be combined with massage. The galvanic current should be used; a flat electrode should be placed over the sciatic notch, and a smaller one used along the course of the nerve and its branches. In very obstinate cases nerve-stretching may be employed. It is sometimes successful; but in other instances the condition recurs and is as bad as ever.

II. DISEASES OF THE SPINAL CORD.

I. AFFECTIONS OF THE MENINGES.

Diseases of the Dura Mater.

Pachymeningitis.—The dura mater of the cord is separated by a loose connective tissue from the bony canal in which it lies, and an inflammation may involve either its outer or its inner aspect; hence the division into pachymeningitis externa and interna.

(*a*) *Pachymeningitis Externa.*—This is invariably a secondary inflammation and is occasionally met with in an *acute* form in caries or in syphilitic affections of the bone. Abscess may penetrate the spinal canal or the inflammation may even extend to the peridural tissue in long-standing decubitus. The symptoms are usually those of a compression myelitis.

The *chronic* form of external pachymeningitis, also a secondary affection, is much more common. It is a constant accompaniment of tuberculous disease of the spine and plays a very important part in the production of the symptoms. The affection may be confined to the part in immediate connection with the local disease, but in some cases the subdural space over six or eight vertebræ is occupied by caseous masses. The cord at the site of the curvature in Pott's disease may be compressed, with perhaps little or no involvement of the pia mater. The internal surface of the dura may be perfectly smooth, perhaps a little adherent to the arachnoid, while the external dura is thickened, rough, and covered with a cheesy substance of a variable degree of consistence. In some instances the dura is completely surrounded by this material; in others it is chiefly on the anterior surface. We can understand the recovery in cases of compression paraplegia if we bear in mind that in large part the actual compression is produced by this material between the diseased vertebræ and the dura mater. The symptoms are those of myelitis from compression, often with signs of involvement of the nerve roots, such as will be mentioned in the next section.

(*b*) *Pachymeningitis interna*, described by Charcot and Joffroy, involves chiefly the cervical region (*P. cervicalis hypertrophica*). The interspace between the cord and the dura is occupied by a firm, concentrically arranged, fibrinous growth, which is seen to have developed within, not outside of, the dura mater. It is a condition anatomically identical with the hæmorrhagic pachymeningitis interna of the brain. The cord is usually compressed; the central canal may be dilated—hydromyelus—and there are secondary degenerations. The nerve roots are involved in the growth and are damaged and compressed. The extent is variable. It may be limited to one segment, but more commonly involves a considerable portion of the cervical enlargement. The disease is chronic, and in some cases presents a characteristic group of symptoms. There are intense neuralgic pains in the course of the nerves whose roots are involved. They are chiefly in the arms and in the cervical region, and vary greatly in intensity. There may be hyperæsthesia with numbness and tingling; atrophic changes may develop, and there may be areas of anæsthesia. Gradually motor disturbances appear; the arms become weak and the muscles atrophied, particularly in certain groups, as the flexors of the hand. The extensors, on the other hand, remain intact, so that the condition of claw-hand is gradually produced. The grade of the atrophy depends much upon the extent of involvement of the cervical nerve roots, and in many cases the atrophy of the muscles of the shoulders and arms becomes extreme. The condition is one of cervical paraplegia, with contractures, flexion of the wrist, and typical *main en griffe*. Usually before the arms are greatly atrophied there are the symptoms of what the French writers term the second stage—namely, involvement of the lower extremities and the gradual production of a spastic paraplegia, which may develop several months after the onset of the disease, and is due to secondary changes in the cord.

The disease runs a chronic course, lasting, perhaps, two or more years. In a few instances, in which symptoms pointed definitely to this condition, recovery has taken place. The disease is to be distinguished from amyotrophic lateral sclerosis, syringomyelia, and tumors. From the first it is separated by the marked severity of the initial pains in the neck and arms; from the second, by the absence of the sensory changes characteristic of syringomyelia. From certain tumors it is very difficult to distinguish, as, in fact, the fibrinous layers form a tumor around the cord.

The condition known as *hæmatoma* of the dura mater may occur at any part of the cord, or, in its slow, progressive form—pachymeningitis

hæmorrhagica interna—may be limited to the cervical region and produce the symptoms just mentioned. It is sometimes extensive, and may coexist with a similar condition of the cerebral dura. Cysts may occur filled with hæmorrhagic contents.

Diseases of the Pia Mater.

(*a*) Acute Spinal Meningitis; Leptomeningitis.

Etiology.—Spinal meningitis occurs: (1) In tuberculosis. This is perhaps the most common form in general practice and has already been considered. (2) In specific cerebro-spinal meningitis, which occurs endemically or epidemically, and has also been considered under its appropriate section. (3) As a secondary involvement in certain infectious diseases, pneumonia, small-pox, scarlet fever, and typhoid fever. This form is very rare. Even in pneumonia, in which the cerebral meninges are frequently involved, the spinal meninges are seldom affected, except perhaps in the first two or three inches of the cervical region. (4) From injury or the extension of inflammation, as after operation on spina bifida. (5) There are cases in which the meningitis appears to have followed exposure to cold and wet.

Morbid Anatomy.—The affection may be diffused over the entire cord or localized to the cervical region. In the early stage the vessels of the pia mater are injected. The fluid in the pia-arachnoid space is slightly turbid. In some intense grades, on opening the dura the contour of the cord cannot be seen, as it is completely enveloped in a sero-fibrinous or purulent exudate, which here and there causes bulging of the arachnoid. Owing to the position of the body, the exudate is most abundant in the posterior part, or sinks to the lumbar region. In acute cases the pia itself does not look thickened, but in more chronic forms the membrane may be grayish and turbid. In a majority of instances, if the inflammation is intense, the exudate is seen in the anterior and posterior median fissures and the cortical portion of the cord is swollen and infiltrated, so the condition can be properly called meningomyelitis. The affection may be limited to the spinal meninges, but in a majority of instances it is a cerebro-spinal lesion.

Symptoms.—These have already been referred to in considering the two commonest varieties, the tuberculous and the epidemic. The disease often sets in with a chill and fever. Pain in the back, stiffness in the neck, pain on pressure along the vertebræ, tremor or spasm of the muscles, and disturbances of sensation are usually present. Girdle sensations are not common. The reflexes may be increased. Later, paralytic symptoms may develop, but they are uncommon, except in pure spinal meningitis.

The *diagnosis* is often difficult. In a large proportion of the cases supposed to be spinal meningitis the membranes are not inflamed. I have already referred to the identity of the spinal symptoms in certain of the infectious diseases with those of acute leptomeningitis. In the case of a patient with high fever, marked stiffness of the back and neck muscles, or opisthotonus with rigidity and tremor of the muscles, it is not unnatural to make a positive diagnosis of spinal meningitis, but every symptom of the condition may be present without any inflammatory exudate. The truth of Stokes's dictum, already quoted (p. 25), has been brought home to me on many occasions. On the other hand, there are instances of well-marked leptomeningitis, more particularly the cerebro-spinal form, in which spinal symptoms are trifling or absent. To distinguish between the different forms of spinal meningitis is sometimes extremely difficult. A correct diagnosis is oftenest made in tuberculous cases, since here the prodromata are well defined and the symptoms indicative of involvement of the cerebral meninges well marked. There are cases in which the spinal meninges bear the brunt of the affection. I have already referred to one case in which the meningitis was thought to be due to traumatism. The coexistence of disease at the apex of the lungs or of local tuberculous lesions elsewhere is of great value.

The diagnosis of the epidemic form has already been considered.

(*b*) Chronic Leptomeningitis.

—As a primary lesion this is extremely rare. It sometimes follows the prolonged use of alcohol. It occurs in connection with syphilis, trauma, and as a complication of various scleroses of the spinal cord, either systemic or insular.

Anatomically the condition is characterized by a thickening and turbidity of the pia, often with adhesions to the arachnoid and the dura. The membranes may be stained with blood-pigment. These alterations may occur in localized spots or over extensive areas. The nerve roots may be involved and thickened. The spinal cord itself is rarely affected, though strands of connective tissue may extend into the cortical zone, producing slight sclerosis. The opaque, white, cartilaginous plates which occur so often on the posterior surface of the spinal arachnoid and are sometimes adherent to the pia cause no symptoms and are not to be mistaken for this chronic meningitis.

The *symptoms* of this form are indefinite. Simple thickening of the meninges may produce no signs during life unless the spinal nerve roots are involved. In any case the diagnosis is somewhat doubtful. There are instances in which pain in the back, stiffness of the dorsal muscles, and pains radiating in the nerves of the trunk or in the extremities have been marked. Hyperæsthesia and skin eruptions may be present. When the cord is involved paralytic symptoms may develop. The reflexes are increased. The course is always chronic, lasting for many years.

The treatment is purely symptomatic. Recovery probably never occurs.

Hæmorrhage into the Spinal Membranes; Hæmatorrhachis.

In meningeal apoplexy, as it is called, the blood may be between the dura mater and the spinal canal—extrameningeal hæmorrhage—or within the dura mater—intrameningeal hæmorrhage.

(*a*) *Extrameningeal Hæmorrhage* occurs usually as a result of trauma. The exudation may be extensive without compression of the cord. The blood comes from the large plexuses of veins which surround the dura. The rupture of an aneurism into the spinal canal may produce extensive and rapidly fatal hæmorrhage.

(*b*) *Intrameningeal Hæmorrhage* is rather more common, but is rarely extensive from causes acting directly on the spinal meninges themselves. Scattered hæmorrhages are not unfrequent in the acute infectious fevers, and I have twice, in malignant small-pox, seen much effusion. Bleeding occurs also in death from convulsive disorders, such as epilepsy, tetanus, and strychnia poisoning. The most extensive hæmorrhages occur in cases in which the blood comes from rupture of an aneurism at the base of the brain, either of the basilar or vertebral. In several cases of this kind I have found a large amount of blood in the spinal meninges. In ventricular apoplexy the blood may pass from the fourth ventricle into the spinal meninges. There is a specimen in the medical museum of McGill College of the most extensive intraventricular hæmorrhage, in which the blood passed into the fourth ventricle, and descended beneath the spinal arachnoid for a considerable distance. On the other hand, hæmorrhage into the spinal meninges may possibly ascend into the brain.

The *symptoms* in moderate grades may be slight and indefinite. In the non-traumatic cases the hæmorrhage may either come on suddenly or after a day or two of uneasy sensations along the spine. As a rule, the onset is abrupt, with sharp pain in the back and symptoms of irritation in the course of the nerves. There may be muscular spasms, or paralysis may come on suddenly, either in the legs alone or both in the legs and arms. In some instances the paralysis develops more slowly and is not complete. There is no loss of consciousness, and there are no signs of cerebral disturbance. The clinical picture naturally varies with the site of the hæmorrhage. If in the lumbar region, the legs alone are involved, the reflexes may be abolished, and the action of the bladder and rectum are impaired. In the dorsal region there is more or less complete paraplegia, the reflexes are usually retained, and there are signs of disturbance in the thoracic nerves, such as girdle sensations, pains, and sometimes eruption of herpes. In the cervical region the arms as well as the legs may be involved; there may be difficulty in breathing, stiffness of the muscles of the neck, and occasionally pupillary symptoms.

The prognosis depends much upon the cause of the hæmorrhage. Recovery may take place in the traumatic cases, and in those associated with the infectious diseases.

II. AFFECTIONS OF THE BLOOD-VESSELS.

(*a*) **Congestion.**—Apart from actual myelitis, we rarely see post mortem evidences of congestion of the spinal cord, and when we do it is usually limited either to the gray matter or to a definite portion of the organ. There is necessarily, from the posture of the body post mortem, a greater degree of vascularity in the posterior portion of the cord. The white matter is rarely found congested, even when inflamed; in fact, it is remarkable how uniformly pale this portion of the cord is. The gray matter often has a reddish-pink tint, but rarely a deep reddish hue, except when myelitis is present. If we know little anatomically of conditions of congestion of the cord, we know less clinically, for there are no features in any way characteristic of it.

(*b*) **Anæmia.**—So, too, with this state. There may be extreme grades of anæmia of the cord without symptoms. In chlorosis and pernicious anæmia there are rarely symptoms pointing to the cord, and there is no reason to suppose that such sensations as heaviness in the limbs and tingling are especially associated with anæmia.

There are, however, some very interesting facts with reference to the profound anæmia of the cord which follows ligature of the aorta. In experiments made in Welch's laboratory by Herter, it was found that within a few moments after the application of the ligature to the aorta paraplegia came on. Paralysis of the sphincters developed, but less rapidly. Within fourteen days contractures of the limbs set in with atrophy and fibrillar twitchings. Histologically it was shown that within thirty-six hours there were marked changes in the ganglion cells of the anterior horns in the lumbar segments, and later there were signs of a definite myelitis. This condition is of interest in connection with the fact of the rapid development of a paraplegia after profuse hæmorrhage, usually from the stomach or uterus. It may come on at once or at the end of a week or ten days, and is probably due to an anatomical change in the nerve elements similar to that produced in Herter's experiments.

In this connection may be mentioned the interesting observations of Lichtheim upon the degeneration of the posterior columns of the cord in pernicious anæmia, of which he has reported three cases. He regards it as a form of toxic myelitis, due to the altered condition of the blood.

(*c*) **Embolism and Thrombosis.**—Blocking of the spinal arteries by emboli rarely occurs. It may be produced experimentally, and Money found that it was associated with choreiform movements. Thrombosis of the smaller vessels in connection with endarteritis plays an important part in many of the acute and chronic changes in the cord.

(*d*) **Endarteritis.**—It is remarkable how frequently in persons over fifty the arteries of the spinal cord are found sclerotic. The following forms may be met with: (1) A nodular peri-arteritis or endarteritis associated