Treatment with insulin was continued in doses of 20 units every four hours during the day, and at 9 a.m. on October 14th the patient was fully conscious and food was begun. On October 17th she was able to chat, and said that she had been seeing animals, and in particular rats, up to this time. She was finally given 15, 10, and 20 units three times a day.

I have met with at least two cases of diabetic coma who have not become fully conscious, in spite of vigorous treatment with insulin, and have eventually died. The blood sugar was high, the values being 0.45 and 0.46 per cent., so that there was no question of hypoglycaemia. Ketones had disappeared from the urine, but the volume of the latter was suddenly greatly reduced, and there was a corresponding retention of urea in the body. In one case the blood urea was 0.2 per cent., and in the other the urea in the cerebrospinal fluid was 0.15 per cent. Death was probably due to uraemia. It is possible that the administration of fluid in bulk, as already described, may prevent the onset of this unexpected complication.

Treatment of Hypoglycaemic Coma.

A subcutaneous injection of 15 or 20 minims of adrenaline (1 in 1,000), or, failing this, the same dose of pituitrin, is given. This treatment will be of value if the liver contains a good store of glycogen. Plenty of sugar—that is, 4 to 8 oz. of cane sugar or dextrose—is given by mouth or by stomach tube. If the patient does not recover consciousness rapidly, an intravenous injection of 5 to 6 per cent. solution of dextrose is given. Up to one pint may be given, but 100 c.cm. will usually be ample. Dr. Hinds Howell¹¹ has recently reported the occurrence of hypoglycaemic coma as the result of exercise at golf in a patient who was being treated with 30 units of insulin twice a day. It has been suggested that such patients should carry sugar with them and wear a label round their necks with instructions what to do in case they are found by anyone in an unconscious condition.

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THE EARLY MECHANICAL TREATMENT OF ACUTE ANTERIOR POLIOMYELITIS.*

BY

HARRY PLATT, M.S., F.R.C.S.,

SENIOR HONORARY SURGEON AND SURGEON IN CHARGE ORTHOPAEDIC
SERVICE, ANCOATS HOSPITAL, MANCHESTER; CONSULTING
SURGEON, ETHEL HEDLEY HOSPITAL FOR CRIPPLED
CHILDREN, WINDERMERE, WESTMORLAND.

It has long been recognized that the serious disablement resulting from acute anterior poliomyelitis is, in many cases, dependent more on the existence of deformities than on the paralysis *per se*. In the treatment of such residual disabilities it is customary to obtain correction of all deformity by appropriate non-operative or operative measures, before carrying out any definitive reconstructive operation designed either to restore muscle balance or to stabilize a flail joint. In children who present multiple contractures of the lower limbs and who have never walked since the onset of the paralysis the preliminary treatment of the deformities may occupy many months. A whole series of manipulative or operative procedures may be required, the deformities being gradually unfolded in successive stages. We have no reason to feel dissatisfied with the functional results obtained under such conditions, because it is rare to meet with a child to-day who cannot be made to walk once deformities have been eliminated, no matter how severe the degree of residual paralysis, provided only that the patient is competent to hold crutches. But every patient so treated brings vividly before the mind a picture of the earliest phases of acute poliomyelitis, a stage when deformities are non-existent. The prevention

of deformity is, of course, by no means a new doctrine. It was expounded many years ago by Hugh Owen Thomas of Liverpool, and has always formed an integral part of the teaching of his distinguished successor, Sir Robert Jones. In this connexion we are also unlikely to forget the work of the late Frederick Batten of London, a physician endowed with surgical instincts. Yet, if we are to judge from the mass of neglected cases, we might be led to the conclusion that such teaching has failed to exert a widespread and lasting influence. On the whole, however, in recent years we are to chronicle a definite advance in the treatment and general handling of poliomyelitis in its earliest stages. To a large extent this has been brought about by the unique experience of a number of American observers, and more particularly perhaps of Lovett of Boston, who has made comprehensive observations on 5,100 cases which have come under his personal supervision since 1916. In the United States acute poliomyelitis is a veritable scourge, and many of the individual States have been compelled to develop special organizations in readiness to handle large epidemics from the outset, and to provide for the subsequent efficient treatment of patients during the recovery period.

In the British Isles the greater proportion of cases continue to arise sporadically, or in small groups, but a number of relatively formidable epidemics have been recorded. Thus, in the late summer of 1911 in the county of Westmorland, some 50 cases were encountered in epidemic form. In 1922 in the same area there was a small epidemic of 15 cases. Many of the children with the late sequelae of the 1911 epidemic have passed through my hands at the Ethel Hedley Hospital for Crippled Children, Windermere, and 9 cases of the 1922 group were admitted to this hospital in the acute stage. Future epidemics in the Lake Country will, I believe, be adequately provided for, the hospital acting in liaison with the health authorities, and thus fulfilling an educational mission to the medical profession and public in the area it serves. In this work we are following the lead given by the Shropshire Orthopaedic Hospital, Oswestry, and the Wingfield Hospital, Oxford. It is a relatively simple matter to cope with an epidemic of poliomyelitis when a well equipped special hospital with a team of expert workers is available, but the mass of sporadic cases seen both in the larger cities and country districts cannot at present be handled under such ideal conditions.

SYMPTOMATOLOGY.

Opportunities for early treatment depend on prompt diagnosis, and the principles on which treatment must be based will be determined by a clear understanding of the character of the primary pathological changes and their mechanical sequelae. It is thus desirable to consider briefly some of the more important clinical features of anterior poliomyelitis, and the nature and extent of the lesions in the central nervous system. It may be suggested that, as a surgeon, I am traversing ground outside my immediate province, but there is an ever-increasing body of surgeons who are best described in the striking phrase of Sir Berkeley Moynihan as "physicians doomed to practise surgery," or who fulfil the spirit of Harvey Cushing's conception that "the physician has become his own surgeon."

Three clinical stages with somewhat arbitrary limits are generally described:

- (1) The *acute stage*, which lasts usually not longer than four to six weeks.
- (2) The *recovery stage*, which extends approximately to the end of the second year.
- (3) The *chronic stage*, from the third year onwards; a period when all the resources of reconstructive surgery are demanded.

It would appear that the initial syndrome is comparatively unfamiliar to practitioners of medicine in general. The variability of the symptoms which usher in an attack of acute poliomyelitis is of course well known, and it is appreciated also that the clinical picture may bear a close resemblance to some of the more commonplace acute illnesses of childhood. Of the signs which may be considered as especially significant three have been found to

* A paper introducing a discussion on this subject before the Manchester Medical Society on January 9th, 1924.

be remarkably constant, both in isolated cases and in epidemics. These are: (a) stiffness in the neck; (b) spontaneous pain in the back and limbs; and—most important of all—(c) marked tenderness of the limbs.

The development a few days later of widespread or localized paralysis completes the syndrome, and ordinarily should point the way to diagnosis, although for some little time the paralysis may be overshadowed by the more dramatic symptoms of pain and tenderness. In young children mistakes in diagnosis are frequent, the condition being regarded as rheumatism, influenza, meningitis, or even acute osteomyelitis. Confronted with such a clinical picture it is important not to forget the seasonal incidence of the disease, and particularly the liability of a child to acquire the infection whilst away on a holiday. In poliomyelitis affecting older children and adults the clinical picture may be still more puzzling, and may tax the diagnostic resources of an experienced neurologist.

The symptoms enumerated above are the expression of the essential pathological changes, which consist briefly in an acute inflammatory reaction of a haemorrhagic type involving the spinal cord, meninges, and—in grave cases—the brain itself. The lesions are at first widely diffused, but their destructive effects are usually confined to restricted areas, the anterior cornual cells in the lumbar or cervical enlargements sustaining the bulk of the damage. The amount of true cell destruction cannot be estimated at this stage, so that it is impossible to give any accurate prognosis regarding the amount of recovery to be anticipated. Mild fleeting cases are familiar in the experience of all clinicians, and it is interesting to note that in the large epidemics of the United States approximately 25 per cent. of the victims recovered completely (Lovett).

The recovery stage proper does not ordinarily extend beyond the end of the second year, but steady and continuous improvement in function may be witnessed for some considerable time in a patient who is under efficient supervision and treatment. In the third year considerable disappointment may be experienced, for definite retrogression in muscular power is not infrequently seen, more particularly in the case of the function of the lower limbs. Muscles which have recovered incompletely may now return to a state of total paralysis. This important fact has been particularly emphasized by Lovett, who has pointed out that the falling off in muscular power is almost invariably associated with the late development of deformities.

TREATMENT.

We may now consider the treatment which is appropriate at this stage, and in the course of which mechanical methods play a leading part. Certain principles, fundamental in surgical therapeutics, must be followed.

1. *Complete rest* is first and foremost. It means in the case of acute poliomyelitis an attempt to protect the inflamed nerve cells from every form of central or peripheral stimulus. This can be achieved in one way only—namely, by immobilizing the patient in the recumbent position in some form of apparatus which maintains complete fixation of the spine and limbs. Two efficient methods are available and are now in common use: (a) the employment of a moulded plaster-of-Paris bed, or (b) a well padded spinal frame of the double Thomas or Bradford type, with the addition of suitable splints for the limbs. Experience has shown that the plaster bed offers many advantages, for, being constructed on the patient himself, it is an accurate fit.

2. *The prevention of deformity* by the adoption, from the moment immobilization is effected, of certain standardized positions of the limbs—positions which are known to be antagonistic to the occurrence of the common contractures. It does not appear to be widely realized that severe fixed deformities may develop within the first few weeks after the onset of the paralysis. The correct position for the lower limb is extension of the hips and knees, with the feet maintained at right angles. This posture will effectively prevent the classical triple deformity of flexed hip, flexed knee, and foot-drop. For the upper limbs the positions are: right-angle abduction at the shoulder, flexion at the elbow with supination of the forearm, and, where necessary, dorsiflexion of the wrist.

3. *Relaxation of the paralysed muscles.* In the very early stages when the paralysis is widely diffused the positions described above represent a compromise, as certain muscle groups do not receive the benefit of the position of full relaxation. At this stage, however, this objection is of theoretical importance only. In any case, in the standardized positions, the muscle groups which receive priority of attention are just those in which recovery is most desirable in the interests of the future functional capacity of the patient. Later, when the recovery stage sets in and the paralysis becomes much more localized, the principle of physiological relaxation may be applied with a greater degree of accuracy.

Once the patient is comfortably installed in his shell or frame, he should be subjected to the minimum amount of disturbance during the following weeks. Frequent examinations made with a view to formulating a prognosis as to the likelihood of recovery are both unnecessary and harmful. It will be realized that a child who is acutely ill, with marked sensitiveness of the skin and muscles in the affected limbs, cannot be moved repeatedly without causing a great deal of distress.

As the pain and tenderness begin to subside the patient will attempt to twitch such muscles as are unaffected or in which rapid recovery has taken place. Such efforts should not be discouraged as long as the standardized positions of the limbs are retained continuously. But they do not point the way to the immediate prescription of any of the manoeuvres of physiotherapy. This stage is to be regarded essentially as one of masterly inactivity. Lovett has well said that "the most striking advances in the treatment of poliomyelitis have been the elimination of meddling therapeutics from the early stage." With the complete disappearance of pain and tenderness and the onset of more obvious muscle recovery, there is no longer any necessity to maintain complete immobilization of the patient as a whole, unless a widespread paralysis affecting the trunk and all four limbs is still present. In these unusually severe cases the child must be maintained in the shell or on the frame for a much longer period. But in the average case the child will be brought into the sitting posture by degrees some time after the fourth to the sixth week. In cases where the abdominal muscles are paralysed but the spinal muscles intact the sitting position is naturally favourable to the occurrence of recovery in the former group. The affected limbs are, of course, still retained in the splints or the remains of the plaster shell, in the standardized positions.

The stage of recovery is now reached; it is a fascinating chapter in itself, but one which does not belong properly to the limits of our discussion. We may thus leave the patient for the moment, with a paralysis which may still be extensive, but—a most important augury for the future—without any deformity. But unremitting care and supervision will be required for a long period, for deformities may yet develop in the later stages after walking has begun.

I am conscious that I may be advocating a doctrine to which many have long ago been converted. But there is still need for a greater diffusion of knowledge concerning the results to be obtained in acute poliomyelitis by the employment of prompt mechanical treatment in the earliest stage.

I should like to emphasize once more the part which the surgeon with special training and experience should be called upon to play in this disease at all stages. One is not infrequently asked, "When does the surgical treatment of poliomyelitis begin?" The answer is always, "As soon as the diagnosis is completed." Do not let there be any misunderstanding. Under the heading of surgical treatment is included the mechanical measures just considered. There is thus great need for a more intimate collaboration between the physician and the surgeon in the treatment of individual cases of acute poliomyelitis in the early stage. From the basis of such "team" work, with the co-operation of the health officers, efficient schemes for the handling of patients *en masse* might easily be evolved, and a great deal of the present-day crippling be abolished.