true respiratory quotient owing to irregularities of the breathing. Yet in such cases as the above there is another factor to be considered. The liberation of alkali in the blood consequent upon the removal of the ketone bodies would result in a compensatory retention of carbon dioxide. This might easily be sufficient in amount not only to mask any rise but even to produce a fall in the respiratory quotient. It will be noted in Fig. 1 that there is a conspicuous fall in the respiratory quotient at the time the increase of bicarbonate reserve is most rapid.

The above results form part of a larger scheme of research undertaken on behalf of the Medical Research Council.

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TRAUMATIC PARAPLEGIA:

OBSERVATIONS ON CASES WITH REFERENCE TO TREATMENT AND PROGNOSIS.

BY

O. H. GOTCH, M.B., B.Ch.Oxon., M.R.C.P.Lond.

THE object of this paper is to give an account of cases of paraplegia of traumatic origin with a view to establishing a rational treatment and prognosis. All the cases are collected together at the Queen Alexandra Hospital Home at Southampton, and afford a unique opportunity for study.

It was rare before the war to meet a group of cases of uncomplicated traumatic paraplegia. The cases discussed in this report are all traumatic; all were young men when wounded, and their general health and strength at the time of the injury were apparently good. The belief is therefore warranted that most of the symptoms are purely the result of the spinal injury. It is possible, therefore, to draw conclusions as to treatment with reference to prognosis. In paraplegia following some particular disease this is not possible, since the pure picture of paraplegia is blurred in with the general symptomatology of the particular disease causing the paraplegia.

Types of Cases.

The number of cases studied was 56, and the average age at the date of injury 21. All the cases when first seen had been wounded for three years, and some for five or six years. Of the 56 cases 39 were of the complete lesion type at the level of the fourth to tenth segments; 17 of the incomplete lesion type, ranging from the eighth to the lower lumbar segments.

In the cases with a complete lesion two well marked types can be distinguished—those with flaccid paralysis (paraplegia in extension) and those with spastic paralysis (paraplegia in flexion). Both types have an equal degree of motor and sensory paralysis extending as high as the original level of the lesion, but in the flaccid type there is a complete absence of all tendon and skin reflexes (with the exception of the anal skin reflex, which in a few cases is present). The lower limbs lie quite motionless, wasted, and shiny. The spastic cases, on the other hand, show an exaggeration of the knee-jerks (the ankle-jerks vary, and are occasionally absent), an extreme degree of ankle and patellar clonus, and a double Babinski response. The limbs appear very irritable to small stimuli; stroking or blowing on the skin surface will generally lead to involuntary contraction, the thigh becoming flexed on to the abdomen. A slight degree of irregular wasting of one or both limbs is to be observed, and the motor and sensory loss is as complete as in the flaccid cases. In both types there is complete loss of voluntary control over micturition and defaecation.

The cases exhibiting an incomplete cord lesion also fall into two types—the spastic and flaccid. The spastic cases have brisk tendon reflexes with pronounced double Babinski toe reflexes and ankle clonus, and the abdominal reflexes are absent. In one case, however, both upper and lower abdominal reflexes are briskly present, the Babinski reflex also being very pronounced. A certain amount of irregular wasting of the calf and thigh muscles may be present. The power of voluntary movement of the lower limbs is considerable, especially after

adequate massage, but walking is generally difficult, since so much energy is expended in overcoming the spasticity.

In the flaccid cases either all reflexes in the lower limbs are absent, or the knee-jerk is just elicitable in one or both limbs. The knee-jerk, if present, is not altered by reinforcement; one smart tap will elicit it, and a series of taps with the patient's hands clenched, etc., do not alter its character. The wasting may be very considerable, especially in the calf muscles, but the thigh muscles may be only moderately wasted. Systematic massage can improve this wasting very noticeably, but the neurological signs (that is, tendon reflexes) do not alter.

Voluntary movement varies. Most patients can stand and walk with aid, the motive power appearing to come from the muscles of the pelvic girdle. The loss of superficial sensation in the lower limbs is of a very patchy and variable nature, the majority showing an irregular riding-breeches anaesthesia with some patchy analgesia over the feet. The loss of muscle and joint sensibility is generally great, and nearly all the patients who can walk can only do so by looking at their feet; they cannot walk in the dark.

The bladder and rectal functions show a varying degree of departure from the normal. The majority of patients are aware of the desire to pass water and can control the passing of it—provided the bladder is not too full or the weather not too cold. Occasionally retention occurs, and a catheter has to be passed or retained for a few days. Five cases have almost normal bladder control but complete faecal incontinence, whilst three have no bladder control but normal rectal control. Sexual impotence is invariable. Priapism is common, and often a most distressing and, if there be obstruction to the circulation by a tightly fitting rubber urinal, a highly dangerous complication.

The blood pressure is within normal limits in all, and there is no difference between the arm and the leg readings.

Special Symptoms in the Complete Type.

The symptoms now to be described are not as a rule found in the incomplete type of paraplegia.

Pain in the lower extremities is described as sharp, gnawing, griping, burning, cutting, and is felt all down both legs; when very severe its onset is acute and there is a rise of temperature, though never above 101° in uncomplicated cases. There is no visible change of any kind in the physical signs. The patient is obviously in very acute pain, and is only relieved by hypodermic injections of morphine. A moderately severe attack is sometimes checked by aspirin, or better with salipyrin (gr. xx). The duration of these attacks is usually about twenty-four to forty-eight hours or less; if longer, some other factor is responsible, such as an old bed sore which has become septic, or renal colic. The patients themselves ascribe these attacks to a change in the weather. I confess myself sceptical on this point, but cannot offer any adequate explanation as to the mode of origin of these pains. The symptoms suggest some irritation of the sympathetic nervous system, especially the pains described as gnawing and griping, and may have an origin in the sympathetic ganglia outside the cord. Whatever the cause, there is no doubt that these limb pains form a very definite part of the syndrome of the complete type of paraplegia. Nearly all the patients complain of a continual sensation of tingling in the lower extremities, but this is not described as painful.

Flatulence is a very common and occasionally an acutely painful complaint. Well marked generalized abdominal distension with ladder-like peristalsis is to be observed, sometimes so great as to suggest definite obstruction. As a rule there is no vomiting, but constant eructations of gas and the passage of flatus per anum. The very severe cases look ill, and present a toxic appearance suggesting uraemia. These cases are relieved by a single injection of pituitary extract (posterior lobe, 1/2 to 1 c.cm.). The slighter cases, with moderate abdominal distension and pain, are often strikingly relieved by injections of mx of 1 in 1,000 liquor adrenalin. hydrochlor., or by double doses by the mouth in ice-cold water. An enema, either simple or mixed with asafoetida, does not appear to relieve

this condition, though, if given soon after the distension has disappeared, it will probably prevent a recurrence.

Renal Colic.—Typical attacks of renal colic are quite common, and occasionally the symptoms are bilateral. There is a decided tenderness in both loins, and usually in those cases of paraplegia that suffer frequently from such attacks a well defined mass in the position of the kidney is palpable. Several cases have shown very large irregular masses in both loins, which have been proved to be enormously dilated pelvis filled with pus and calculi, and surrounded by a grossly fibrotic kidney substance. The passage of blood-stained purulent urine usually follows after the attack has subsided, and may continue for several days.

Chronic Urino-genitary Sepsis.—Under this rather cumbersome title I place all the complete paraplegics—that is, those patients with complete paralysis of micturition. Although the urine may appear clear and free from pus by gross tests, there is always present a cloud of albumin on boiling after adding acetic acid, and microscopically there is always evidence of a continually progressive breaking down process in the uro-genital tract in the shape of pus cells, bladder and renal epithelium, etc. At any time this process may become suddenly acute, resulting in a rapidly developing pyonephrosis, with an increasing mass in either loin, and high fever or cystitis, prostatitis, orchitis, or epididymitis. It is common to find a patient with no gross external evidence of an acute infective process, but with an irregular fever of months' duration, before the temperature finally returns to a normal level. I have regarded such cases as due to chronic sepsis in some portion of the uro-genital tract. I have often overlooked the prostate as the seat of infection in such cases, and in one case cautious prostatic massage led to the expulsion of a quantity of extremely offensive blood-stained pus, and the fever subsided. In massaging the prostate in these cases extreme care must be exercised, since if the massage be too vigorous a most alarmingly profuse haematuria will occur and take several days to subside.

Uraemic Manifestations.—Uraemia is the last stage in these cases. In a few instances it supervenes quite gradually without any very prominent symptoms. In one patient, who had been up and about for months, and seemed in good health and spirits, I noticed one morning that the respiration was peculiar, suggesting asthma. He said he felt very sleepy, but complained of no discomfort. The same evening twitching was observed, and coma rapidly supervened. No urine had been passed for twenty hours. Pilocarpine injections and hot packs were ineffectual. In other cases, however, the uraemic symptoms are most distressing, and continue for days; intractable vomiting and headache are prominent symptoms. The urine may show a practically normal measure or be entirely suppressed. I have never observed renal oedema of the eyelids, face, or back in any of these cases, and the eye-grounds have also been entirely normal, even in those patients who have shown symptoms of repeated slight uraemic attacks. The *post-mortem* findings are what one would expect. There is no naked-eye appearance of any true kidney substance. The kidneys are replaced by what looks like an irregular abscess cavity with fibrous walls, its interior filled with calculi and pus; the ureters are very much thickened, and occasionally filled with calculi. Slight cases of uraemia may recover under vigorous treatment (prompt injections of pilocarpine and hot packs, with abundant fluid by mouth), but I have not seen recovery in cases showing twitching even where the other symptoms are quite mild.

Bedsore.—These as seen in the cases under discussion are, for the purposes of treatment, conveniently divided into wet and dry. An old dry bedsore may remain stationary for years, and, unless very roughly handled, will not cause any trouble. A discharging bedsore, on the other hand, may defy the most energetic treatment in the shape of ointments, rest, and a variety of dressings and lotions, and get deeper and wider. I have no faith in any one particular line of treatment. I remember one patient who had had the most scrupulous aseptic treatment directed to a large extending bedsore with no avail;

finally it was decided to abandon the dressings and allow the bedsore to take its chance in a dressing largely composed of faeces; the result was complete healing within a few weeks. I can only attribute the healing of a bedsore to some personal factor in the patient, and assume that the reaction towards healing depends more on the general than on the local condition. As a rule dry dressings for dry bedsore and wet (preferably hot) dressings for wet sores give the best results. An extremely useful ointment for a clean but extensive bedsore which shows little sign of healing is that supplied by Messrs. Christy and Son under the trade name of "Sobrefacien."

General Treatment.

The incomplete cases with recovered bladder function show a gradual tendency to improve. Daily massage, systematic walking exercises, encouragement in self-confidence, all help this improvement. Such patients may with confidence be told that they will lead useful if restricted lives, and that no relapse need be feared. The completely paralysed patient, however, is in a different class. His progress cannot be other than gradually downward. Treatment, therefore, should be directed towards the retardation of that process as much as possible. Expert nursing, massage, and suprapubic drainage of the bladder are the essentials of treatment. I am convinced that the complete cases who have retained their suprapubic drainage apparatus have in all instances lived longer and have been very much freer from intercurrent symptoms than those without. Some of these cases with suprapubic drainage were wounded six or seven years ago and have hardly experienced the slightest discomfort. In patients with suprapubic drainage I have never observed any of the symptoms referred to above, such as acute pains in the lower limbs, abdominal distension, or intermittent fever of a severe and protracted nature. All the cases exhibiting such symptoms have either never had suprapubic cystostomy or the original suprapubic opening had been closed at some later date in their paraplegic history. Out of eight deaths two were in suprapubic cases, one of whom died of septic arthritis accidentally caused through injury; the other case died of uraemia.

There appears to be no doubt that as far as the patients' general condition is concerned suprapubic drainage has a great advantage over a closed automatically acting bladder. The bladder is washed out twice daily and the tubing changed. A solution of 1 in 8,000 to 1 in 10,000 potassium permanganate is the most effectual irrigating lotion. The best type of rubber drainage tube is an oesophageal tube. It is soft and does not cause trouble round the opening. For the complete cases I usually prescribe a routine mixture, to be taken thrice daily, of—

R. Urotropine	...	...	...	...	gr. x
Ammon. benzoat.	...	...	...	...	gr. xv
Tinct. hyoscyami	...	...	...	...	℥ xxx
Syrup. aurantii	...	...	...	...	ʒj
Aq. ...	...	...	...	...	ad ʒj

Ammonium benzoate, when taken over long periods, does not cause digestive upsets like the acid sodium phosphate. The urine can generally be kept at a constant level of acidity by this therapy. I have found that tincture of hyoscyamus very appreciably diminishes the tendency to acute retention in cases without suprapubic drainage.

In cases without suprapubic drainage a retained catheter is used if there is a tendency to spasmodic retention. I have not found any harm result from employing a retained catheter for an indefinite period. The urethritis which may result can be quite easily controlled by sufficient lubrication of the catheter and irrigation of the urethra with 1 in 8,000 potassium permanganate solution.

Massage of the lower extremities, back musculature, and abdomen is absolutely essential in all cases of paraplegia, whether complete or incomplete. Without it the patient very quickly develops contractures, and bedsore on the feet appear; his general condition deteriorates, and he becomes very much weaker, so that he will be unable to sit up if he is a completely paralysed patient of a high level type. Massage should be given daily.

It does not appear to influence the acute pains in the lower limbs.

The importance of nursing in these cases cannot be overestimated. In fact, without the special care that the patients receive from the nursing staff at Gifford House I doubt whether any of the complete cases would be alive to-day.

Prognosis and General Summary.

In the complete cases the prognosis cannot be other than ultimately fatal, but in the absence of definite uraemic symptoms it is almost impossible to predict an immediately fatal issue. Even where a patient may seem semi-moribund, with foul discharging bedsores, intermittent fever, and rapid general wasting, there is quite a chance that he will make a good recovery and be up in his chair again. A patient with extensive osteomyelitis of the spinal vertebrae following a bed sore gradually pulled round and the condition entirely healed. On the other hand, I have not seen recovery following any uraemic nervous symptoms, even when the patient's general condition appeared quite good. It is always safe to predict rapidly developing coma and death when such symptoms exist. Acute haemorrhagic cystitis is always rapidly fatal; it may come on without any warning at any time during the patient's paraplegic life. I have seen two deaths from this condition, both in patients without suprapubic drainage. The mental factor undoubtedly plays a very large part in the grip that the patient has on life. A greatly depressing shock of some kind, the death of a friend, or serious trouble of any sort, will be sufficient to depress the patient's vital powers. He will become silent, depressed, refuse food, look increasingly ill, begin to develop bedsores, and may die if his confidence is not restored.

The main factors influencing prognosis appear to be:

1. Continued and skilled nursing.
2. Daily massage.
3. Establishment of adequate bladder drainage, preferably by the suprapubic method. Closure of a suprapubic cystotomy opening which the patient has had for some years and which is giving no local trouble is entirely contraindicated. This statement has been put to the test in five of the complete cases, and in all five symptoms have developed, such as bedsores, limb pains, fever, and malaise, which were not manifest previous to the closure.
4. Encouragement of mental confidence and mental occupation. In this respect an auto-wheel chair of special pattern has been found invaluable. It saves the patient any unnecessary friction, and enables him to get about and enjoy life, and generally assists him in forgetting the tragic aspects of his disability.

A NOTE ON THE VALUE OF SYMPTOMS IN THE EARLY DIAGNOSIS OF PULMONARY TUBERCULOSIS.

BY

D. G. MACLEOD MUNRO, M.D., M.R.C.P. EDIN.,

DEPUTY COMMISSIONER OF MEDICAL SERVICES FOR TUBERCULOSIS TO THE
MINISTRY OF PENSIONS.

THESE remarks are addressed primarily to the general practitioner, upon whose failure to diagnose pulmonary tuberculosis in its early stage some quite unjustifiable aspersions have been made from time to time. It is, indeed, encouraging to note how keenly the general-practitioner has recently taken up this question and with what comparative success, especially on the lines of more recent views on physical diagnosis. It is not my intention to discuss this question from any original or novel standpoint, but I am inclined to think that we should seriously consider whether in this connexion the pendulum has not swung rather too far in the direction of diagnosis from purely physical signs.

The time is, I think, ripe to seek an adjustment of values between the two chief factors in the early diagnosis of pulmonary tuberculosis—namely, its symptomatology and physical signs. In a disease in which so many clinical and anatomical phenomena have to be correlated, and in which

the same individual may present a new symptom complex every few weeks, the position of the diagnostician is not always a happy one. It is only by painstaking adjustment of all the contributory elements in such cases and in the use of skilled judgement in interpreting the clinical picture thus presented that success will attend efforts to make a diagnosis in these difficult cases.

I am not aware whether it is still the rule, but until very recently I understand the diagnosis of pulmonary tuberculosis in the army was not regarded as established unless the tubercle bacillus had been found in the sputum; and it is not so many years ago that in civil practice the earliest recognition of the disease was based upon data which at the present time are considered to be the sign of a comparatively advanced stage. In auscultation, for example, it may not yet be generally appreciated that what is to be looked for is a change in the breath sounds of the *inspiratory* phase, which may be noted at a much earlier stage of the disease than alteration in the *expiratory* phase which may be present in many quite healthy chests.

The change of method in the elucidation of physical signs during the past few years has been, indeed, quite revolutionary, and thanks to Riviere and others, certain refinements in physical examination have materially assisted in the earlier recognition of the disease. The utility of inspection and palpation has been especially developed by the American school, and the value of these methods of physical diagnosis greatly enhanced. Hitherto inspection of the chest has been, from the point of view of the general practitioner, rather a perfunctory affair, and the virtues of palpation limited to vocal fremitus—now regarded as of doubtful value as a diagnostic sign in such cases. Now that special attention is being paid to the muscle reflex which results in what is known as "lagging" (the presence of which, especially at an apex, strongly suggests active mischief, although percussion and auscultation may give no indication of this) inspection and palpation assume a more important place. The proper appreciation of this sign requires practice, but this is soon acquired.

The information conveyed by inspection in these cases may be greatly reinforced by light finger-tip palpation, by means of which evidence of localized reflex muscle spasm—especially as affecting the sterno-mastoid, the scaleni, and the upper pectorals—may be detected. The trained finger appreciates in such cases a sense of muscle resistance in contradistinction to the smooth and more elastic sensation of normal muscle tension. Then, too, trophic changes in the muscles of the shoulder girdle and the state of the subcutaneous tissues may be similarly recognized. In the opinion of some experts, indeed, light touch palpation has very largely replaced percussion as an aid to diagnosis.

The technique of percussion, too, has been much improved, and it is now generally recognized that to be of any real value, apart from other points of detail, percussion must be light. But this method of physical diagnosis still presents many pitfalls, and, apart altogether from the question of accuracy, it must be strongly affirmed that local changes in the percussion note, especially at the apex of a lung—even if the existence of such cannot be doubted—convey nothing as to the presence of an active tuberculous lesion, or, indeed, that the lesion, if such exists, is tuberculous at all.

In my opinion, too much attention in the matter of percussion has been focused upon the definition of certain areas of the chest wall called after some eminent authorities. It is questionable, for example, whether in the early cases of pulmonary tuberculosis now under discussion any appreciable change can be found to have occurred in Krönig's area of so-called apical resonance. In rather a different category are the "bands of impairment" in the percussion note first noted by Abrams. These bands are said to be purely reflex in origin and to be one of the earliest indications of active pulmonary tuberculosis. My own experience of this diagnostic sign is not extensive, but I confess that in a number of cases in which I have utilized this method of physical diagnosis I have never been able to satisfy myself as to the reliability of the results.

But if we may gratefully acknowledge that a great deal of useful work has been done by what I may perhaps refer to without offence as the "physical force" school, we must admit, I think, that on the question of the early diagnosis