An Address

ON

THE TREATMENT OF PARALYSIS IN CHILDREN.

DELIVERED TO THE SECTION OF DISEASES OF CHILDREN
OF THE ROYAL SOCIETY OF MEDICINE,

BY

SIR ROBERT JONES, K.B.E., C.B., CH.M., F.R.C.S.,
PRESIDENT OF THE SECTION.

A BODY such as this Section of the Royal Society of Medicine is of inestimable value in bringing together the physician and the surgeon in their manifold activities, and I would emphasize again that a specialism should be attained by a process of mental evolution, and be practised only after a thorough grasp of the fundamental principles of medicine and surgery has been won. Even now there should be a closer association between the work of the physician and that of the surgeon; they are not practising two different arts, and in a large number of cases their combined energies should be devoted to a common end.

On a visit recently with Sir Anthony Bowlby to one of the hospitals in the United States we were impressed by the fact that Harvey Cushing and his class went round the orthopaedic wards with Lovett and his class, and a return visit was paid to the neurological wards. Problems of common interest were discussed and valuable suggestions made. It would be to the common good if physician and surgeon in our teaching hospitals, with their students, could meet in common in the wards. The surgeon, if he is receptive, has always something to learn from the physician, and the physician may sometimes glean a stray idea from the surgeon. Take a group of cases with potential deformity, say the osteoarthritic group. The surgeon with his mind obsessed by deformity is very apt to think that his whole duty is to correct it, and no serious attempt is made to check the infection; while the physician may ignore the sure onset of deformity in his eagerness to discover a microbe. This is all wrong. If we walk round a ward where such cases abound we find ankylosing ankles in full extension, flexed knees and hips, and crooked spines. Yet all these are preventable. The student who becomes the practitioner is encouraged to look upon such results as the inevitable sequence of disease with far-reaching evil effect. A closer affiliation between physician and surgeon would obviate all this; the applied knowledge of each is essential to the scientific conduct of the case. The practitioner in the remote village would then know that such cases have both a medical and a surgical aspect, and, as he has to practise both as a physician and a surgeon, the knowledge would relieve him of serious responsibility. Medical sins of omission and surgical sins of commission would both be prevented by a closer affiliation of these great branches of our profession.

I propose to deal with some points in the treatment of the paralyses in children, affections which require the close association of neurologist and surgeon. Poliomyelitis is the most common of the paralytic affections attacking the child, and yet it is not sufficiently emphasized that this affection may not be accompanied by paralysis. Paralysis is incidental, not essential.

The many and very extensive epidemics that have occurred in America, and their careful tabulation by Lovett and others, confirm the conclusion of observers in other countries that there is considerable variation in the onset, although, generally speaking, it is that of an acute infection. I can recall several instances in which I have failed to obtain any history of an acute beginning. In one remarkable instance three children were affected in one family. In one of the children extensive paralysis followed an acute onset; in another the acute onset was followed by pain, but no evidence could be gathered of even a transient paralysis; in the third child extensive paralysis occurred suddenly, with no febrile symptoms and no complaint of pain. In quite a number of cases hyperaesthesia appears before the paralysis. It is difficult to elicit a reliable history of the sequence of symptoms in young children. We are better able to obtain information from young adults; some of them have noted a numbness preceding the loss of power, while others have complained of a burning sensation in the extremities and sometimes of shooting pains. In one case, following a febrile attack, the right leg was affected and, four months later, the

quadriceps of the opposite leg. Such late developments, however, must be very rare.

We are accustomed to look upon the first stage as extending from the onset until all pain has disappeared. If there is no pain, or very transient pain, it is wiser to consider the first or acute stage as lasting six weeks, but so long as pain lasts we must look upon it as indicating active irritation of the cord. I have known the stage of pain to last for nine weeks; in that case, although the paralysis was extensive, it was of a very transient character. Lovett tells us that in America it has proved very necessary that the surgeon should be possessed of the evidence upon which a diagnosis of poliomyelitis has been made. They found it imperative to have recourse to lumbar puncture, because many abortive cases occurred which were potential dangers to the family and State; only in this way could the isolation of the abortive case be secured. It had the further advantage of securing rest in the pre-paralytic stage, and of arousing suspicion whenever a transient weakness was discovered in a muscle or muscle group. We must bear in mind that while lumbar puncture is valuable for diagnostic purposes, it is also a mode of treatment which has proved of benefit in the acute stages of the affection.

The second period usually lasts for two years, and corresponds to the absorptive changes in the cord. During part of this stage the motor area is frustrated in its efforts to send impulses to muscles; in time, however, some of the paths recover and muscular power returns. Even while the power returns, trophic disturbances begin, affecting both circulation and growth, and it is in this period that deformities appear, unless appropriate measures are adopted. The surgeon, unfortunately, too often comes on the scene only in time to correct conditions which should not have arisen, and when preventive measures are too late. The reflex arc being broken, the reflexes in the affected area are diminished or lost. The electrical examination of the paralysed muscles is only of value when the tests are carried out by an expert. If the muscle retains its faradic excitability when tested a few days after the onset of the disease, a good prognosis may be given. If, on the other hand, the muscle has lost its faradic excitability, and the response to interrupted galvanic stimulation is slow (the reaction of degeneration), this is evidence of interruption of the lower motor neuron, and the prognosis is correspondingly more grave. From the electrical examination at this stage no accurate prognosis can be given as to the ultimate fate of the affected muscles. The difficulties of diagnosis during the stage of onset are sometimes complicated by pre-existing conditions, such as shortening from fracture, congenital dislocation of the hip, infantile hemiplegia, and in one very interesting case I remember the spasmodic conditions of the limbs due to spastic paraplegia were considerably modified by a superimposed poliomyelitis.

In the early days of treatment it is usually impossible to state the degree of shortening which will ultimately persist. It is very rare to find a shortening of more than three inches. The shortening is not definitely proportionate to the degree of residual paralysis, but bears a closer relation to trophic changes. In one case there was complete paralysis of the right leg and a mere paresis of the left quadriceps, yet the left leg was an inch shorter than the right. In another instance a paralysis confined to the calf muscles resulted in a limb with two and a half inches of shortening. It is equally difficult to foretell the degree of recovery of function. Although it is unusual, I have seen cases in which a muscle has only begun to improve after three years of complete paralysis. When the stage of onset and tenderness is protracted, recovery of the muscles is usually postponed, but the improvement continues for a longer period. Lovett has pointed out, and I can confirm it from my own observation, that cases which present a fairly complete paralysis below a definite level are unfavourable, and that cases which have a considerable amount of total paralysis persisting after three months will only make a very partial recovery. There are, however, notable exceptions.

TREATMENT.

Intimately connected with the question of prognosis is that of treatment, which very largely influences it. From the onset to the end of the second stage, and even later, we have to avoid meddlesome methods, and to recognize that muscles we are apt to look upon as paralysed may after all be merely weak. I pointed out, many years ago, that a muscle exhibiting the reaction of degeneration is not necessarily outside the pale of hope, and that while we may be certain that if

a muscle reacts to faradism it will recover the converse does not always hold. Prognosis is more hopeful if from the first we visualize the obstacles to recovery and avoid them.

Rest.

The early treatment of poliomyelitis is usually the responsibility of the general practitioner, who has to direct the case on correct principles. During the stage of onset we must trust entirely to rest, and even then protect the muscles which are weak and obstruct the coming of deformity. The head and spinal column should be kept absolutely at rest in obedience to the general law as applied to inflamed structures. Rigid fixation of the head and spine is a relief to pain, but if the pain is slight for physiological reasons rest is imperative. The appliance should be cosy and so constructed that nursing is rendered harmless, and nothing should be allowed to take place which might conceivably frighten the child. Body and mind should be kept at rest. While active mischief is present in the cord electricity and massage should be avoided. It is not physiological to irritate and stimulate peripheral ends of nerves connected with inflamed centres. The practice is irrational, cruel, and reactionary. Applications of heat and cold are equally to be condemned. We are dealing with a damaged cord, which must be zealously guarded from fussy therapy. Deformity must be prevented at this stage as well as at every other, and this can be done without any irritation to the child. We must remember that deformity involves a loss of power both in the contracted and in the overstretched muscle groups. The deformities which we usually have to guard against are: contraction of the feet in plantar flexion, flexion of the hips and knees, adduction of the shoulder, and curvatures of the spine. If the child is on a frame soft pillows can be used to correct other deformities; but again I would repeat that nothing is to be done in any way likely to worry the child. Crying is one of the worst evils to inflict upon a tender head and spine.

Before approaching the second phase of treatment I must beg of you, as I have so often done before, to remember that a muscle which is submitted to stretching will lose its function, and that we must draw a distinction between a muscle paralysed by destruction of its governing cell and a muscle disabled and impotent from overstretching. This was pointed out by Thomas forty years ago. It is the fundamental element in our treatment of the disabled muscle. In poliomyelitis the factors that are at work in abnormally elongating muscles are—unopposed muscular action; the influence of gravity, as in plantar flexion of the ankle; deflection of body weight in walking, such as occurs in the foot when, in paralysis of the tibial group, the patient walks on his inner ankle. I will not spend time in giving concrete examples and proofs; they have on several occasions been supplied in abundance, but, although there is a general agreement with the theory, practice leaves much to be desired. If by stretching a normal muscle for a lengthened period we deprive it of power, how important it becomes that a partially paralysed muscle, struggling for function, should receive a helping hand! It cannot be too strongly stated that a paralysed muscle should be kept relaxed, without a solitary break in continuity, until recovery occurs. This should be done at once, for when the deformities become fixed the contracted muscles become structurally shortened and, in accordance with a well-recognized physiological law, all the tissues on the contracted side participate in the change. From this it follows that, in paralysis of the deltoid, the arm should be kept abducted; in paralysis of the flexors of the arm the elbow should be kept flexed and pronated; when the foot has lost the power of dorsiflexion, it should be maintained in dorsiflexion—and so, in all deformities, the functioning muscles should be stretched and the weak ones relaxed.

The next principle I would emphasize is that as recovery begins to take place the relaxation must be lessened by small degrees, the extent being regulated by the patient's ability to make use of the muscle in the extended range. There is yet another important fact—namely, that if a muscle is over-exercised it will begin to lose power. I have met with many instances where a recovering muscle has lost all its power when it has been given its liberty too soon. We must therefore be careful not to overtax a weak muscle. Cases are continually occurring where recovery ceases in a muscle asked to do more work than it is physiologically capable of doing.

In this second stage we are constantly called upon to correct deformity which, as we know, if left may deprive the

lengthened muscle of all hope of recovery; but we must also remember that the shortened muscle is also weakened, because its range of movement is necessarily confined to a limited radius. I will not enter into details of the methods employed to correct deformity; it is enough to say that it can be done by a splint and bandage, and that in the lower extremities we secure the assistance of gravity. Excepting in extreme instances the knife is never needed. The correction is called for in the case of the lower extremities in order to enable the patient to stand and walk with or without assistance, and to attain this end without the production of secondary deformities. In the case of the upper extremity, deformities are corrected mainly in order to obtain function.

Massage.

As soon as the patient is made straight, we devote our attention to the development of his muscles. This is a long and arduous task and too often becomes a routine. "Give the child massage" is often the prescription, as though it were a dose of castor oil. Our aim is to develop the weak muscles and not the strong ones, and yet massage and exercise as usually practised bring into play most prominently the muscles which we should desire to neglect. It is the duty of a physician or surgeon to instruct the masseuse as to her line of conduct, and to explain to her what is needed, and why. We then obtain intelligent co-operation. We shall then know that the muscles will not be fatigued, and that while they are massaged they remain in a position of relaxation and that all the movements are of a kind not calculated to strain the weak group. If the extensors of the wrist are weak, the wrist-joint will be kept dorsiflexed and not once allowed to move in the direction of plantar flexion. If the dorsiflexors of the foot are under treatment, the foot should never be plantar-flexed below the right angle; and both in the wrist and foot the fingers and toes should be actively exercised before an attempt is made to move the heavy joints.

Colin Mackenzie, in his suggestive work on the action of muscles, emphasizes the necessity of minimizing strain on weakened muscles during their re-education. A man suffering from a recovering deltoid, who cannot elevate his arm beyond a right angle when he stands erect, and is opposed by gravity, can complete the range of movement if he lies on a flat table covered with chalk in order to avoid friction, and so with the other groups. By this means very early voluntary effort becomes effective. The splints during this period should be so designed that no pressure on muscle can take place, and, where possible, massage should be practised without their removal.

Muscle Re-education.

Muscle training is of extreme value. It is based on the principle of concentrating the patient's attention so that brain cell and muscle will work in accord. Everything should be eliminated which interferes with the untrammelled action of the paralysed muscle, and when the slightest response follows an effort the enthusiastic expert will almost supply the patient with energy to persevere.

We can perhaps best illustrate this in the case of a limb with paralysis of the quadriceps. Very slight voluntary movement should be started early, but that movement should not be allowed to act on the joint, for the muscle is not strong enough to act against any such resistance. The knee, therefore, is kept fixed in full extension in order to rest the quadriceps. The first sign of recovery will be watched for, and the moment a voluntary twitch is observed education is to be commenced. The masseuse teaches the patient to practise drawing up the patella. When this can be done, she is then told to put her finger against the upper border of the patella and to give a little resistance to the action of the muscle. To allow the child to flex her knee at this stage would be to invite calamity. When the muscle has gained considerable strength the rigid splint may be changed for one that allows only a few degrees of flexion, and as soon as the patient has muscular control of the knee within that radius the range of flexion can be increased by degrees. The massage should be gentle in these early stages, for considerable damage is done if rough. All we can expect from it is an improvement in the nutrition of muscle. I could give scores of instances where recovering muscles have weakened by fatigue from immoderate exercise and from energetic massage. Recovery from this is brought about by rest. My experience coincides with that of Lovett, who has drawn attention to the dangers of overexercising a weak but recovering muscle. He instances the gastrocnemius muscle:

"a normal gastrocnemius should be able to raise twice the body weight; if it is reduced to one-quarter of its normal strength by a paralysis it is easy to see that walking is a continued overuse of this muscle. Nowhere have I seen the effects of overfatigue more clearly exemplified than in the observation of this muscle. If the muscle is protected, much walking prevented, and a very high heel put on to throw it out of action, as a rule it is amenable to treatment, and I have seen instances where in a year or so the muscle returned to its full normal strength; but I have never seen a case of any considerable weakening of the gastrocnemius muscle do otherwise than badly when walking was allowed freely and the leg not protected by a high heel." This is all borne out by examples we commonly see where paralytics who are undergoing intensive treatment make no progress until they are laid up by some other affection, and the muscles instead of deteriorating gain considerable power. Experience justifies us in concluding that exercise without weight-bearing should be continued until the muscles have gained considerable strength, and that when the time for walking comes it should be regulated with scientific precision.

Electrical Stimulation.

I have spoken of rest, massage, and muscle re-education, and these are the means which appeal to me as of the greatest value; but electrical stimulation is a legitimate and useful means of giving certain muscles a mild and beneficial exercise, and the object of the treatment is to make the muscles contract. It is harmful as well as useless to immerse the affected limb in a bath and allow the current to pass through the water. If any action results it will be contraction of the normal muscles and stretching of the paralysed ones.

During the convalescent stage until there is recovery of faradic excitability interrupted galvanic stimulation is employed. It should be possible in a majority of cases for a specially trained masseuse, loyal to instructions, to stimulate the paralysed muscle to contract without the spread of the stimulus to the normal ones. Faradic stimulation is of service only with recovering muscles which will again react to this form of stimulus, or for those muscles weakened but not paralysed. Fatigue must not be brought on; the electrically provoked exercise must stop short of this. It should be painless, or practically so, and not cause terror to the child. If it does, it should be discontinued. For reasons that are obvious a paralysed limb should always be kept warm.

Correction of Deformities.

As the object of treatment is to secure for the patient the highest possible degree of function we must prevent or obliterate all deformities. Deformities are primarily due to the contraction of muscles; other preventable factors assist. Although they can be rectified at any stage their persistence through the early months will have inflicted very serious damage to the weak muscle groups. I have seen marked contractions of the hips in five weeks after the onset, and of all deformities, if allowed to become fixed, they are the most difficult to deal with—if we exclude scoliosis—and are a prolific cause of secondary deformities. They occur with greatest certainty where the glutei are weak and the flexors retain some power. They are favoured by sitting and crawling, and are best treated by the use of a double frame, so that the stretching may be continuous. Treatment by posture, such as lying on the face, is less effective, as it is intermittent and violates the fundamental principle we have enunciated in regard to the stretching of muscles. The same criticism applies to scoliosis. There is no position like the recumbent one until the maximum of recovery is assured.

Shoulder contractions are also obstinate, and are due to paralysis of the deltoid and overaction of the pectoralis major and latissimus dorsi; the arm should be abducted from the first, and if adduction has occurred the deformity may be corrected by stretching and an abduction splint applied, as advised by Colin Mackenzie. To see a paralytic child, unprotected, sitting or lying in a heap is a pathetic instance of surgical ignorance or neglect. Deformities, where possible, should be rectified by mild and persuasive means, but there is no excuse in these days which can be accepted to explain either their occurrence or continued existence. Much can be learnt from the gait of paralytics, as so well described by Lovett. When the gluteus maximus is paralysed we find that when weight is borne on the affected side the body is thrown back with a sudden lurch and the patient hurries with the other leg. It is like that of a patient with an amputation of the

upper third of the thigh wearing an artificial leg. Paralysis of the adductors does not cause much limp, but it can be detected by asking the patient to put one foot directly in front of the other. With weak adductors this can only be done by swinging the body.

If the hip flexors are involved the patient brings the affected limb in front by a forward twist of that side. In paralysis of the quadriceps one of several methods may be adopted. He may keep the knee from flexing as he walks by pressing the thigh back with one hand, or as the affected limb touches the ground the patient hyperextends the knee to lock the joint; both these practices produce genu recurvatum. Again, he may walk with his leg rotated outwards to avoid the action of gravity; if he has strong hamstrings he can lock the knee without fully extending, simply by bending the whole body forwards.

The gluteus medius, an antagonist to the adductors, draws the thigh outwards when the pelvis is fixed, or abducts the trunk when the thigh is fixed. Its paralysis causes a characteristic gait. When the patient bears weight in walking on the affected side he lurches over to that side in an attempt to balance, and the lameness is often indistinguishable from that caused by marked shortening of the leg. Lovett has shown us that the limp is largely obliterated during the examination by giving the patient a weight of five to fifteen pounds to carry in the hand of the affected side. It changes the centre of gravity and compensates for the weakness of the muscle.

With weak abdominal muscles the patient stands and walks sway-backed with the hip flexed, marked lumbar lordosis, and prominent abdomen. Unilateral paralysis of the abdominal muscles causes the patient to drop the pelvis on the weak side in taking the weight on the good leg. It is similar to the position taken by a patient with congenital dislocation of the hip when standing on the affected leg. I need not describe other gaits, but it will be seen that by observing the patient's walk the more characteristic paralyses may be noted.

In the third or chronic stage, when all the recovery we can expect has occurred, the surgeon's task is one of restoring his patient to usefulness. The correction of deformity is absolutely essential, for no muscle can be restored unless this is done, and from the mechanical side it is impossible to walk with joints flexed or hyperextended. Of the methods by which we correct various deformities I need only say they are simple. That our present methods will be improved is a commonplace, but there is no reason even now that paralysis should be followed by deformity, except scoliosis, and there is no reason why, if deformity has been allowed to appear, it should not be corrected by one of many means at our disposal.

Splints are used for three objects—the prevention of deformity, the correction of deformity, and to assist the function of the upper arm or locomotion in the lower limb. They should be simple in design and made of light material only just sufficiently strong to effect their task. They must be looked upon as the lesser evils, and when they can be safely discarded they should. In the lower limb apparatus is indicated if the patient cannot walk so well without such aid, or if he can only walk or stand in a position of deformity. When a splint is applied, we must carefully note whether its use prevents or induces secondary deformities. But granted that apparatus in itself is undesirable, the conditions which it is put on to prevent are still more undesirable. These are inability to walk, the acquirement of malposition and permanent deformity, and the stretching of paralysed muscles. We must remember that deformity starts as a postural malposition, becomes fixed by adaptive changes in the soft parts, and progresses to permanent bony deformity in accordance with Wolff's law. These deformities are of every type—dislocation of the femur, knock-knee, genu recurvatum, flexed joints, subluxation of the tibia, contracted and dropping of the shoulder, and scoliosis.

When we come to a general consideration of operations we find they are of two types: one to stabilize a flail joint by operation on the skeleton, the other to restore muscular balance. Our views on the value of arthrodesis have been modified of late years as the result of the introduction of other methods. In the knee-joint it is never necessary in children, and but very rarely in adults. The inconvenience of a stiff knee is a serious one, and the problem is better dealt with by the application of a splint which will permit of flexion. The same may be said of the hip. Arthrodesis of the ankle yields at best an imperfect functional result, and although, perhaps, at times desirable in adults, it is contra-

indicated in young children, and less desirable in older children, than other methods at our command. Arthrodesis of the astragalo-calcaneal joint, so performed as to correct any lateral deviation in the foot, is proving of increasing value, for excessive lateral mobility without stability is difficult of control by mechanical means. Arthrodesis of the shoulder is of considerable advantage when the deltoid is irrecoverable and the function of the rest of the arm is good. Before it is performed the muscles of the shoulder girdle must be working, as the object of the operation is to fix the head of the humerus into the glenoid at an appropriate angle so that the arm may be moved by the scapular muscles. In children over 10 the scapular movements become very free as they grow up, and after an arthrodesis the arm can be placed to the back of the neck, and into the trouser pocket. This operation should be but rarely performed in the adult, and its limitations should always be fully described to the patient.

In a technically successful operation in an adult the patient was dissatisfied with the result because previously she could do her hair and fasten the back of her dress by placing the paralysed arm in position with the other, whereas after the arthrodesis the inability to mobilize the scapula sufficiently in adult life prevented the extremes of motion required in these two movements. As a preliminary to arthrodesis of the shoulder intensive exercises for the scapular muscles are needed, and unless the patient can shrug the shoulder with considerable power arthrodesis is contraindicated.

If an arthrodesis is performed on the adult the arm should be fixed in abduction at a lesser angle than in the case of a child. In the child the scapular movement can be considerably increased over the normal range during the years of growth. In the adult there is a danger, if the abduction is extreme, that the arm cannot be brought to the side. This is a very serious functional result.

Tendon transplantation is beginning to appear in its true perspective, and the complicated operations in vogue some years back are no longer performed. Its object is to improve or to restore muscular balance, and it is to be condemned unless it is performed with a reasonable chance of improving function. The transplanted muscle should become a true substitute for the muscle which is paralysed. It may be performed in order to prevent or correct deformity, and the recent tendency of surgical practice is to employ it in conjunction with operations designed to improve stability. Its task in that case is not so responsible as when the transplanted tendon is called upon to do the whole of the work itself. Tendon transplantation is a procedure which calls for sound judgement and irreproachable technique.

Every case represents a separate anatomical problem, and it is not indicated unless there are normal tendons to transplant. The question of operation does not arise when the muscles are all partially paralysed. If nothing has been done in order to relieve the paralysed muscles from tension an operation is not justified until relaxation has been tried, and it is fundamental that all deformity should be fully corrected before a transplantation is done. Naughton Dunn of Birmingham has lately made a distinct advance in the treatment of paralysed feet which require apparatus, by shortening and stabilizing the foot. The operation consists of arthrodesis of the astragalo-calcaneal joint and the removal of various portions of bone from the tarsus, retaining the function of the ankle-joint and fortifying plantar flexion by transplantation of the muscles which pass to the sole into the tendo Achillis. I examined some fifty cases upon whom this operation had been performed, and the results were excellent, most of the patients walking without apparatus.

Associated with the success of tendon transplantation is the recognition of those principles which bear upon the relaxation of muscle and fatigue. Any attempt to overwork a transplanted tendon results in weakening it, and until it gains strength it should be treated as if it were partially paralysed. Massage and re-education should be conducted in the absence of weight-bearing.

With improved technique the operation of tendon fixation has gained in surgical esteem, and has made much headway since Tilanus introduced it, much of the improvement being based on the experimental work of Gallie. It consists of the utilization of paralysed tendons as ligaments. The success depends largely upon the anchorage being made very near the articular ends of bone on both sides of the joint, so that a very short piece of tendon is under strain. For instance, in paralytic foot-drop, the tendon of the paralysed calf muscles is divided, and the lower end split longitudinally, one half

being brought through the tibia and the other through the fibula, with the foot kept at a right angle. In this way we form a very firm ligament, which prevents dorsiflexion of the foot. These fixation operations have supplanted the employment of silk ligaments, but the practical point wants emphasizing—that it is essential the tendons should be fixed just above and below the joint, in order to minimize the danger of stretching. More lately free fascial transplants are being used to form ligaments, but our experience is not sufficient to allow a considered judgement.

The tendency of modern surgery is to stabilize the ankle, and the surgeon calls to his aid a variety of methods. If he deals with a calcaneo-cavus where only the flexors of the toes are working, and perhaps the peronei, he first performs arthrodesis of the calcaneo-astragaloid joint to give lateral stability, and then of the front of the foot, shortening it at the same time. He does not touch the ankle-joint. The peronei and flexors of the toes are passed through the back of the os calcis. If the muscles are weak and will not bear the full strain of body weight, the lower portion of the impotent tendo Achillis is transformed into a strong ligament. In short, he employs arthrodesis to shorten the foot so that leverage is rendered less harmful, and to prevent lateral instability; he employs tendon transplantation to supplant a paralysed calf muscle, and he limits the movement of the ankle by a tendon fixation in order that the transplanted tendons may be saved from fatigue. This is excellent team work, in which all the structures of the foot participate. For pronounced knock-knee, so often found in neglected paralysis, subcutaneous osteotomy is sufficient.

The deformity produced by shortening can now be overcome by an operation devised to lengthen the femur, just in the same way as we lengthen a tendon. If the shortening is the result of a paralytic dislocation the displacement can be reduced and the capsule plicated. In fact, there is no deformity to be met with that should baffle surgical art. Operations, however, are but incidents in the treatment of paralysis, and it is upon recognition of sound principles in the after-care that we depend for the restoration of function.

Nerve transplantation, which at one time seemed so reasonable, is no longer practised, and our observations during the war upon nerve transplantation in paralysis of the peripheral nerves confirm us in discouraging it in infantile paralysis. The direct neurotization of paralysed muscle is only in its experimental stage, and the result will be followed with great interest and considerable misgiving.

My apology for bringing before so learned an audience these elementary but practical principles is that I fear that, even in high places, men are content to give them a mere academic homage.

The Milroy Lectures

ON THE

INFLUENCE OF INDUSTRIAL EMPLOYMENT UPON GENERAL HEALTH.

DELIVERED BEFORE THE ROYAL COLLEGE OF PHYSICIANS
OF LONDON ON MARCH 9TH, 14TH, AND 16TH, 1922,
BY

MAJOR GREENWOOD,

READER IN MEDICAL STATISTICS IN THE UNIVERSITY OF LONDON;
FORMERLY STATISTICIAN TO THE LISTER INSTITUTE.

LECTURE II.

I HAVE pointed out the difference between the courses of the death rates at ages in England and Sweden through the last sixty years, how greatly our mortality has improved both absolutely and relatively to that of Sweden in the younger age groups, how unfavourable is the comparison at later ages. Our later adult mortality was indeed still deteriorating relatively to that of Sweden as recently as 1890, and a subsequent improvement has only brought it within 42 per cent. of the Swedish rate. Nor if we compare typical districts of England can it be said that the regions with a high initial rate, such as Lancashire, have improved much faster than those, such as the South-Western Group of Registration Counties, with an initially low rate. If the comparison be extended to other countries the same conclusion is reached, that expressed by Dr. Stevenson in the following words:

"Considering the whole country as a single area of urban type in comparison with other countries the same feature is observed. Our position is relatively very favourable in early adult life, and