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## THE TREATMENT OF NERVE, MUSCLE, AND JOINT INJURIES IN SOLDIERS BY PHYSICAL MEANS

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CAREFUL analysis of four thousand cases returned from overseas during the period between July 12th and December 29th, 1916, shows that there were one thousand men suffering from gunshot, shrapnel, and shell wounds, five hundred from disorders of the nervous system, four hundred from injuries to bone, and four hundred heart and lung cases, excluding tuberculosis. Allowing for overlapping in this total of twenty-three hundred, at least 50 per cent. of returned men would require some treatment by electricity, hydro-therapy, radiant heat, massage, or muscular reëducation.

The sporadic wounds produced in civil life have been multiplied by war into groups. The exceptional has become the ordinary. Torn and mangled bodies have to be patched and remade, and functions, lost or weakened, must be gradually coaxed back toward normal by means that in pre-war days we often neglected or even despised. Old conditions have come up with new names, and new conditions have had to be met by a rearrangement and application of old means.

Before the war physical therapy was in the hands of a few enthusiasts in the profession, but when the need became urgent, a cry was raised throughout England and France for medical officers who knew how to apply it, and the war will not be an unmixed

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evil if by its means these physical agents are more closely incorporated in the future practice of medicine and surgery.

In the great orthopædic centres established throughout England by Lieutenant-Colonel Sir Robert Jones, inspector of orthopædics, in the sixteen or more command depots scattered over the British Isles by the director general, Sir Alfred Keogh, each housing more than four thousand men, these methods form the backbone of the treatment, and the Surgeon General of the United States has already sent over a contingent of orthopædic surgeons to make themselves familiar with the subject and to establish centres to accommodate thirty-five thousand cases in France.

Canada has not been unmindful of her responsibility to her returned men, and the Military Hospitals Commission is rapidly providing the staff and equipment necessary to bring back as many men as possible to usefulness in civil life.

While the conditions in Canada must, of necessity, differ from those in an English command depot, it is interesting to know that during the first six months of treatment in the command depot at Heaton Park about twelve hundred men (nearly 50 per cent.) were returned to the fighting line by this treatment alone, while another 30 per cent. were made fit for service on the lines of communication or more sedentary work at home, the average time spent by each patient being under three months. The details of this work I have described elsewhere (see *Proceedings of the Royal Society of Medicine*, 1916, volume ix, surgical section, pp. 31-62), but whatever the conditions under which the work is done, the means are the same, and the results are sure.

Briefly stated, the conditions to which physical therapy applies, are as follows:

1. Injury to peripheral nerves, all the way from the bruising of a nerve trunk to its destruction and restoration by surgical means. These injuries are accompanied by weakness or paralysis, muscular wasting, and contractures, conditions met by the application of wet or dry heat to keep up the circulation; support in proper position by splints, to prevent the overstretching of weakened muscles, and the resultant permanent contraction of those that are unimpaired; galvanic, and afterwards faradic, stimulation of the affected muscles; massage to keep up or improve their nutrition, passive movement to prevent contraction and limitation of the normal range of the joints; progressive active movements, joint by joint, to bring back and strengthen voluntary power, and later,

gymnastic and vocational training to fit the patient to fill with skill and efficiency his place in civil life.

2. Scar tissue, either in preparation for, or after operation. The bullet may leave a small entrance wound, but its course through the tissues may leave great areas in which muscle, fascia, tendon, nerve, periosteum, and skin are matted together in one confused distorted mass, strangling the circulation and leaving the limb blue, clammy, moist with continual perspiration, and so painful that the patient winces at the slightest touch. Such wounds are treated by the whirlpool bath, which in twenty minutes changes the cold purple of the painful hand into a warm crimson, and enables the masseur to stroke, knead and otherwise move a joint in a way that no amount of persuasion would have made tolerable. The hastening of repair in these scars by diathermy and ionization, and the stretching of beginning contractures, by careful manipulation are among the triumphs of these methods.

3. Old septic wounds, long since healed, are frequently persistently painful, and a focus of infection may be discovered by massage. It is a frequent experience for a masseur to find part of a long scar become painful, then red, and finally to see a sequestrum or other foreign body extruded that would have lain for months a source of trouble, without the stimulation of heat and massage to hasten its removal. Naturally, such cases need most careful supervision, and a rough and unskilled operator may easily do more harm than good. Electricity, heat, and massage have thus a most important place in softening scar tissue, either before or after operation, and making the work of the surgeon easier.

4. In all post-operative conditions the cure must be completed by physical means. It is not enough to break down an adhesion or restore a joint to potential usefulness. Its nutrition must be improved, and the patient must be taught to use it. Even if it is possible to move it throughout its whole range a cure is not complete until the patient can do this himself with power and skill. He must be taken through a course of reëducation, beginning with free simple movements, advancing to those that are harder and more complex. Devices for this purpose must be designed and employed to prepare him for the more complicated actions required by the craft he may elect to practise.

5. Functional neuroses, which take the form of palsies, contractures, loss of sight, speech or hearing, areas of anæsthesia, or hyperæsthesia, show many marvellous cures by physical means. Contractures are slowly stretched and kept in place by splints,

systematically massaged and exercised by the faradic battery where voluntary movement cannot be obtained, and brought back to usefulness by a combination of hypnotism, suggestion, encouragement, and the gradual replacing of them by voluntary movement. The operator here must be both priest and physician, for the mental is even more important than the physical treatment, and these very real conditions, beyond the patient's control, in most cases, require persistent intelligent treatment, sometimes over long periods of time.

6. The conditions variously grouped under the name "shell shock" which vary all the way from minute hæmorrhages into the brain substance, caused by concussion, to fear and intolerable weariness must be treated by this means. When the soldier in the trenches begins to move his head rhythmically, to twitch his arm, or clutch at the sound of a shell, the regimental surgeon, if he is wise, sends him back to the rest camp for a week or two. If he is kept until the inevitable smash comes, his recovery will be a matter of months, at best, and he is usually put out of commission permanently. Tremors, coarse and fine, up to the point of a general convulsive seizure, rhythmic movements, increasing when the man is spoken to, and calming down when he is left alone are characteristic. Many of these men are martial misfits, never built for the enormous stress of modern warfare, and rapidly go to pieces under it. They usually present a history of nervousness, frequently with enlarged thyroid, rapid pulse and prominent eyes, and all such cases call for rest and sedative treatment, by the continuous bath at skin temperature (94°), hours of rest in bed daily, and the substitution of gentle massage and electricity for active movement at first, with a gradual increase of exercise, beginning with a slow walk and ending with gymnastic games and vocational training.

7. The "soldier's heart" is but a symptom of overstrain. The rapid pulse and breathlessness, the enlarged thyroid, all show the nervous origin of the conditions now known familiarly to medical officers as D.A.H. The faradic or high frequency current, the sedative bath, gentle massage and rest quickly reduce a rapid pulse rate and allow him to bear without danger, an increasing load in the form of gymnastic exercise, walking, and manual labour.

8. Debilities, whether due to typhoid, dysentery or exhaustion are built up again and made ready for service by graded exercises of effort, like light gymnastics, and of endurance like walking, until they can stand the amount of work to which they were formerly accustomed.

9. The place of physical remedies in the treatment of sprains and after fractures, in rheumatism and gout, in flat foot and other postural defects need not be discussed here. Enough has been said to show that the majority of the men who fill our war hospitals, command depots and convalescent homes must depend for most of their present treatment, and for their future efficiency, on the masseuse, the practitioner of electro and hydro-therapy, the physical instructor and the teacher of vocational training. The course usually followed begins with preparation by heat, either wet, dry, or produced by electricity, on through the stimulation of nutrition by massage and passive movement, then to simple exercise taken voluntary and eventually to skilled movements by gymnastics, games and handicrafts.

The equipment necessary consists of:

#### ELECTRICITY

1. The galvanic or continuous current produced by chemical means which causes no muscular contraction except when interrupted. The body contains a large amount of sodium-chloride and other salts in solution, and the constant current splits the salts into their constituents, the metallic portion being attracted to the cathode and the acid portion to the anode. Fatigue products may thus be sent on their way and the "refreshing" action of the current produced. It has a profound effect on metabolism, and salts of lithium, sodium and potassium can be driven into the tissues by its means, a method known as ionic medication. For painful conditions like neuritis, neuralgia and inflammation, the anode is applied, and for any condition requiring active hyperæmia, like Volkman's ischæmic contraction, the cathode is used. The interrupted galvanic current is of use in muscle testing where its chemical action on the muscle produces a sluggish contraction where no response to faradism can be obtained.

2. The faradic or alternating current produced by induction. This acts on a muscle very much like the normal nerve impulse in a healthy muscle. It is conducted along the nerve and enters the muscle through it, throwing it into a series of contractions, synchronous with the make and break of the current. It acts as a substitute when the normal nerve impulses are not fully conveyed to the muscle and can be used to increase nutrition and circulation in partial paralysis. It may be necessary to use both currents in some cases because the faradic does not touch those muscles or parts of muscles which do not respond to it, and the

galvanic may be necessary to reach them and give an even contraction.

These two currents are combined on a medical switchboard or earth-free pantostat, although the faradic is usually replaced by the sinusoidal, which is a current interrupted and reversed in such a way that its strength, starting at zero, rises in a curve to its apex on the positive side, declines to zero, and then rises in the same way on the negative side producing a series of sine curves on alternating sides. It is less painful than the usual faradic current. The faradic is given alone by small portable batteries, preferably of the Smart-Bristow type, and is of great value in exercising weakened muscles by graduated contraction.

3. The high frequency current used in diathermy is a current of high tension and small volume, produced by a special apparatus. It has no power to contract muscles, but produces heat caused by the resistance of the tissue through which it passes. It is useful in producing hyperæmia in parts where the circulation is deficient and as a preparation for a massage or movement. It causes an immediate sensation of warmth and has great powers of deep penetration.

#### RADIANT HEAT

Radiant heat is applied by means of electric lamps and causes a dilation of the surface capillaries, flushing the skin. It also makes an excellent preparation for massage in scar tissue, myalgia, and in joints that are stiff and cold or rheumatic. The most available forms are:

1. A lamp of about sixty candle power contained in a metal cone with a reflecting surface. This is moved about a few inches away from the surface of the part to be treated until the surface is well reddened, a process requiring three or four minutes.

2. Local electric light baths composed of six to twelve, sixteen candle power lights in a closed metal case lined by a reflector. The temperature is indicated by a thermometer and may be raised to 180°, the treatment lasting up to twenty minutes. It is especially valuable in painful rheumatic joints, myalgia, and sprains, and makes an excellent preparation for massage.

3. The cabinet, or full electric light bath, containing a large number of electric lights. In this cabinet a patient is completely enclosed except for his head. The temperature beginning at 100° is brought up to 180° and is indicated by a thermometer. Cold compresses are wrapped about the head and the treatment

lasts about thirty minutes. It is used to increase general elimination and is of value in all forms of intoxication—alcoholic, gouty, rheumatic, or nephritic.

#### HYDRO-THERAPY

1. Hydro-therapy plays an important role in the treatment of the wounded man, as it has the additional resource of cold as well as heat. The cases that derive most benefit from hot water are great areas of contracted scar tissue, painful stumps, weakened and stiffened joints. Slight adhesions may be broken down frequently after its use, and all parts are more easily manipulated.

Irritable bruised nerves are made worse by heat, so that for them baths should not be raised above 100° and manipulation or massage should never be used, the water should here act as a comforting poultice.

1. A sort of gymnastics of the circulation is given by the alternate use of heat and cold water in the Scotch douche or the local contrast baths, advocated by Sir Robert Jones.

2. The full sedative bath at 94° lasting for an hour is of great value in shock and in D.A.H. cases.

3. The whirlpool baths, first used in France during the war are the most valuable single appliance in the after-treatment of wounds. The arm or leg is plunged into a vessel containing water at about 105° which is circulated by jets, set at an angle, or by a propeller. Air is also introduced so that the limb is surrounded by a swirling bubbling current, the temperature of which is raised as high as 120° if the patient can bear it. The air bubbles increase the stimulant effect on the skin and the heat is applied to the surface far more surely by this means than if the water were still. These baths are particularly effective for painful stumps, painful scars, partial paralysis or in fact any condition which lowers the circulation and nutrition of the member. The period of treatment is about twenty minutes and the part, made warm and comfortable, is then ready for massage and manipulation, which could not have been performed without this preparation.

#### MASSAGE AND PASSIVE MOVEMENT

Little headway can be expected until the physiological effect of different forms of massage are clearly understood by both the physician and the masseur. Aimless rubbing is useless, and rough manipulation is dangerous, and frequently one form of massage

may be good when another form is bad. Light stroking is especially useful in painful conditions and as a first procedure in a general treatment. It would be used about adherent scars, over effusions, and over surfaces in which the bone is close to the skin as in the scalp. It acts as a nerve sedative and as a mild stimulant to the surface circulation.

More vigorous friction reaches the deeper parts, wakes up the circulation and forces it on mechanically. Consequently its direction is usually the same as that of the venous circulation. In kneading, the skin moves with the hand like a glove, and large muscle masses are compressed and relaxed. Fatigue products are thrown into the circulation and the nutrition improved. This manipulation is specially useful in reaching deep scar tissue and in stretching it. None of these procedures should be followed by persistent pain.

Striking or beating is a surface or deep manipulation and is done in many ways. By it the nerves are stimulated and reflex contraction of organs like the heart and stomach is produced. Vibration is a rapid form of beating, given by a vibrator at a rate varying from five hundred to five thousand strokes to the minute. It is a stimulant to both nerve and circulation and in addition is most useful for stretching scars and tracing up nerve trunks.

Passive movements should be given by a trained operator, rather than by a machine. Their place is in the stretching of scars, increasing the range of stiffened joints and in rehearsing all the movements of joints whose muscles are paralyzed or weakened. They are of value in detecting and preventing beginning contractures.

Passive movements should not always accompany massage and may be contraindicated, as when a scar is incompletely organized. Here they may do great harm by breaking down the walls of vessels in course of formation in the scar and producing bleeding with subsequent further contraction. They should be slow and insistent, rather than quick and jerky. They prevent adhesions from reforming after an operation for fibrous ankylosis, and they can be used without an anæsthetic in breaking down adhesions when they are not too firm. In such cases the joint should be moved through its range once only, and kept at rest between treatments. It should never be worried by repeated and partial movements, but in the choice and extent of treatment, the surgeon must judge each case on its own merits.



## ACTIVE MOVEMENT

Active movements may be free, but as a muscle works better against a certain amount of resistance, apparatus is necessary to measure the amount of work done and the distance the load is raised. Free movements are merely a rehearsal of the motions of which a joint is capable and need not be described in detail, but even if a limb is fixed by a splint, muscles can be twitched by the patient and so receive a certain amount of exercise, without any active movement taking place in the joints involved.

Most appliances for giving exercise are cumbersome and expensive, and it has been our endeavour to design machines that would fulfil the following conditions:

1. To isolate the movement and so prevent the mistaken idea of improvement when it is really another group that is doing the work.
2. To record the range of movement, so that both patient and the operator can follow the progress of improvement.
3. To measure the dose of work in terms of the number of contractions and weight raised.
4. To be simple and cheap in construction, so that they can be easily made by a good carpenter, and discarded when no longer required.

With this in mind, crude appliances were designed and put in operation at Heaton Park in 1916, much experimentation has been carried on at Hart House, Toronto, and the Military Hospitals Commission has constructed a standard set at its workshops in Guelph, for use in hospitals throughout Canada.

They consist of the following appliances:

## FOR THE UPPER EXTREMITIES

1. A finger board for stretching contractions and for giving abduction to single fingers.
2. A finger treadmill for voluntary flexion of single fingers against increasing weights.
3. Finger pulleys for flexion and extension of all joints of the finger against increasing weights.
4. Pulleys for thumb adduction and abduction against increasing weights.
5. A wheel for wrist circumduction, a stretching movement.

6. Pulley for wrist adduction and abduction against increasing weights.

7. A roller for wrist flexion and extension, against weights.

8. A handle for pronation and supination, against increasing weights.

9. A triplicate pulley weight with handles at the ground, shoulder height, and above the head, for exercising the elbow and shoulder joints, giving flexion and extension of the elbow as well as—

10. Shoulder rotation.

11. Shoulder adduction and abduction, flexion, and extension.

12. A creeping board for stretching the shoulder joint in abduction.

#### FOR THE LOWER EXTREMITIES

1. Inversion and eversion of the ankle, (a) against increasing weights, and (b) by walking on treads inclined inward and outward.

2. Dorsi flexion of the ankle against increasing weights.

3. Rotation of the knee in flexion, against increasing weights.

4. Circumduction of the ankle, a stretching movement.

5. Knee flexion and extension.

6. Hip adduction and abduction.

7. Hip flexion and extension.

(The last three given on the triplicate machine).

8. A combination of thigh flexion, knee flexion, and foot dorsi flexion by means of an inclined ladder.

9. A combination of thigh extension, leg extension, and foot plantar flexion by means of a bicycle trainer.

Each of these exercises is repeated up to the point of fatigue and the improvement is marked on the scale of specially designed protractors, and by measuring the weight lifted and the number of repetitions.

The operator should follow the patient through his entire treatment, beginning with the preparation by electricity, baths, or radiant heat. He should give the massage and passive movements and direct the active movements. When the improvement is sufficiently advanced, he can turn over the patient to the gymnastic instructor who groups him with a small squad for class gymnastic exercises, and to the instructor in vocational training.

## GYMNASTICS

Gymnastics should be considered as part of the treatment in most cases whether the recovery is complete or not, a contracted finger or a stiff knee should not prevent the patient from doing most of the movements in a gymnastic table and the general exercise and discipline contributes to his cure. The two tables of Swedish remedial exercises, designed and already in use for convalescents, are arranged with no jerky or violent movements at first so as to avoid the possibility of injury from overstrain. As the patient improves, he may be given simple dancing steps to music and so progress to tag and other gymnastic games. The formal gymnastic tables are largely for discipline, accuracy, and control and should occupy but a small part of the hour, the rest being given over to games with medicine ball and basket ball, or such sports as handball, bowling or quoits. In this way discipline is combined with treatment and recreation and the man is prevented from forming those habits of idleness that unfit so many hospital patients for civil life after their discharge.

## OCCUPATIONAL THERAPY

As soon as possible, men should be set at some occupation in which they will use the affected arm or leg, not consciously, but to accomplish some definite task. Driving a nail, pushing a saw, or handling a spade will supplement and soon replace the more accurate but less interesting work of the treatment room. The clumsy fingers become nimble, in typewriting, weaving, splicing or modelling and the practice of these trades must be regarded as important parts of one general and progressive system of treatment.

The success of physical means in the treatment in these conditions depends on well trained operators.

In Canada there are now two schools turning out graduates trained in the use of electricity, hydro-therapy, radiant heat, massage and corrective exercises, muscular and educational, and I trust this will be followed speedily by a course for the medical officers who will be put in charge of this important department of treatment. Such a course should consist of:

1. Orthopædics, to include the use of splints for all orthopædic conditions, the construction of shoes to correct foot deformities, the demonstration of nerve suture and tendon transplantation, the after treatment of stumps and the fitting of artificial limbs.

2. Electricity to include lectures and demonstrations in the use of galvanism, faradism, diathermy, and ionization; instruction in muscle testing.

3. Hydro-therapy to include demonstrations and practice in the giving of the douche and whirlpool bath, and the sedative bath.

4. Thermo-therapy to include demonstrations and practice in the use of the lamp and cabinet bath.

5. Massage to consist of demonstrations and personal practice in each form of manipulation including passive movement.

6. Reëducation to consist of demonstrations and practice in the use of each of the appliances for reëducation provided by the Military Hospitals Commission.

7. Gymnastics to include practice in going through two tables of Swedish remedial exercises for convalescent soldiers, dancing steps and gymnastic games.

8. Observation and lectures on occupational therapy.

Such a course would prevent medical officers from being put in the false position in which they so often find themselves, of having to direct treatment with which they are not familiar.

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THE News Bulletin No. 11 draws attention to the increasing prevalence of lobar pneumonia and the danger of infection in this disease.