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REHABILITATION OF THE INJURED

BY

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Since the outbreak of war considerable interest has been aroused in the subject of "rehabilitation," and it is therefore important that the meaning and application of this word should be clearly defined. Unfortunately, different people use it in different senses. Sometimes it is used to denote the training of cripples for special occupations adapted to their disabilities; but this is not rehabilitation, it is vocational training, and should always be referred to as such. Rehabilitation is an entirely different process, the object of which is to cure or reduce disability resulting from trauma so that the injured person is enabled to return to his ordinary work in the industry in which he was formerly employed or, failing that, to useful alternative work in the same industry. Vocational training is essentially a process of compromise with disabilities that must be accepted as permanent, and is necessary only in the relatively few cases in which rehabilitation fails. The more thoroughly the problem of rehabilitation is tackled the less need there will be for vocational training.

Standardization of Results

It is obvious that the difficulty of the problem depends on the nature of the work for which the patient has to be reconditioned. If a carpenter sustains a compression fracture of the spine or a fractured femur he will be fit for full work at a stage in which a miner is only fit for what is euphemistically described as "light work" in a pit. It is difficult to suggest a universal standard by which results may be assessed and compared, but in my own work amongst injured miners return to full work has been adopted as the criterion of full recovery. Return to permanent "light work" is classified as permanent partial disability, and inability to do any useful work in a pit is regarded as permanent total disablement. To appreciate these standards something must be known regarding the nature of a miner's work. To get to it he usually has to walk several miles underground on difficult surfaces. The head-room of his working space averages about three and a half feet, but may be as low as two feet. The average amount of coal which each man hews and loads at the coal face under these cramped conditions is twelve tons per shift, but it may be as high as eighteen in an easily worked seam. Finally, there is no really light work in coal-mining, and the jobs that are usually given under this heading are the equivalent of full work in most other industries.

These standards are unusually severe tests of recovery, but they have the advantage of searching out imperfections which less exacting methods fail to disclose. Half the cases in my fracture clinic—that is, about 1,200 a year—are those of miners injured at work, and it is in

respect of these that statistics are kept regarding restoration of working capacity.

The Miners' Rehabilitation Centre

My experience in rehabilitation as a special problem is derived from the Miners' Rehabilitation Centre at Berry Hill Hall. This centre was established by the Midland Colliery Owners' Mutual Indemnity Company in association with the Bolsover and Butterley Colliery Companies, and is at the service of the entire coalfield, which extends over seven counties. It is administered by a committee consisting of two representatives of the Owners' and two representatives of the Miners' Union. The rehabilitation problem in coal-mining is a very big one because the accident rate is so high (five times higher than the average industrial accident rate), the injuries are of a severe type, and there is no really light work to offer disabled men. Among the 100,000 men employed by the owners concerned in this scheme there are 18,000 accidents a year in respect of which compensation is paid; 6,000 of these men are totally incapacitated for more than a month, and 800 for more than six months. It is chiefly from the latter class that the cases for the rehabilitation centre are drawn. In my own fracture clinic about 15% of the cases are transferred. These are of three kinds:

(a) Severe injuries—e.g., fractured femur, compression fracture of the spine—which on past records have a high risk of permanent partial disablement as judged by the criterion of return to full work as miners. These cases are transferred as soon as the men are capable of undertaking daily exercises.

(b) Cases which have come to a standstill short of full recovery, however simple the original injury might have seemed. Formerly these men were sent back to light work in the hope that it would prove remedial and that they would progress to full work in the course of time. A recent survey has shown that in fact 60% of such men remain permanently on light work. The reason for this is not far to seek. Light work, if it is to have any remedial value, must be selected, supervised, and graduated by the surgeon, just the same as any other form of occupational therapy. In actual practice light work usually terminates the surgeon's connexion with the case.

(c) Cases in which some permanent disablement is inevitable from the outset but in which much can be done to reduce this and so restore to permanent light work patients who might otherwise have been totally disabled.

The Miners' Rehabilitation Centre is a modernized country mansion with 100 acres of grounds, to which a first-class gymnasium and a remedial workshop have been added. It is not part of a hospital, and this in my opinion has definite psychological advantages. Patients who live near enough are allowed to attend daily, but

those from further afield and all who are under-nourished or whose home circumstances are in any way unsuitable are kept in residence. The treatment is intensive and individual, and consists of graduated remedial exercises, occupational therapy, physiotherapy, and remedial games. Perhaps most important of all is the daily and hourly preaching of the gospel of rehabilitation—that recovery can only come by the unremitting hard work of the patient himself.

Importance of Soft Tissues

Before describing these methods of rehabilitation in detail I would like to draw attention to certain general principles which have an important bearing on the earlier stages of treatment. Recovery of function depends ultimately on the muscles, which may be affected either directly at the time of injury or by atrophy due to disuse. Direct trauma may mean actual laceration as in a compound fracture, simple contusion as in the case of a long bone ensheathed in muscles (e.g., fractured femur), or over-stretching as in hyperflexion fractures of the spine. The difference between immobilizing a normal muscle and immobilizing a damaged muscle is that whereas both undergo atrophy, the latter is much more liable to undergo contracture as well, owing to the organization of traumatic ex-

dates into fibrous tissue. The degree of contracture will depend on the severity of the initial damage and the duration of immobilization, and its effect will be to cause limitation of movement in the joint over which it acts. If, for example, an uninjured quadriceps is immobilized for ten weeks in the treatment of a fractured tibia and fibula full movements of the knee-joint are usually recovered within a week of removing the plaster; but if a contused quadriceps is immobilized for ten weeks in the treatment of a fractured femur, flexion of the knee-joint takes months to recover, and the majority of cases never recover full flexion.

The chief problems encountered in the later stages of rehabilitation result from the immobilization and disuse of damaged or normal muscles—loss of power due to atrophy, stiffness due to contracture, and pain due to localized fibrosis. These are the disabilities that remain with the patient for ever—the true “end-result disabilities” that so often spoil a good radiographic result. If every case were regarded from the first not simply as a fracture but as a soft-tissue injury complicated by a fracture there would be less danger of looking upon rehabilita-

tion as a sort of salvaging process to be undertaken in the remote future. On the contrary, the attitude of the surgeon should be such that conservation of function in the soft tissues becomes a major issue from the very beginning. A wasted fibrotic muscle is not an act of Providence and it cannot be cured by the laying on of hands or any other mysterious process in the physiotherapy department. It is as great a reproach to the surgeon and a greater handicap to the patient than a malunited fracture, because whereas the latter is a mechanically correctable disability, the retrogressive changes that take place in neglected muscles are incurable once they have passed a certain point. It is the responsibility of the surgeon to see that they do not pass this point during the period of immobilization.

Conservation of Muscle Function

Conservation of muscle function during the period of healing of the fracture applies both to the parts that are immobilized and to those that are free to act but are out of functional use. A few examples will serve to illustrate the principles involved.

1. In a “below-the-knee” plaster (e.g., in a fracture-dislocation of the ankle) the object of a walking-iron is to make the patient use his quadriceps against the resistance of body weight, which is infinitely more effective for conserving their function than non-weight-bearing exercises of the knee-joint. The calf

muscles, however, are the real problem in these cases. They cannot exercise at all in a normal sense; but, even so, they need not be regarded as out of the picture until the plaster is removed. The synergic action of muscles should be taken advantage of. If the toes are actively and strongly dorsiflexed the plantar flexors of the ankle-joint immediately contract synergically. They do this in order to fix the ankle-joint, which would otherwise be dorsiflexed by the extensors of the toes; but the reflex is so fundamental that they still contract even when the joint is already fixed in plaster. If toe exercises are done strongly enough and regularly enough in such a case the synergic contractions of the leg muscles induced thereby will be sufficient to prevent a good deal of wasting and fibrosis during immobilization. Similarly, in an arm plaster, if the fingers are strongly flexed the extensors of the wrist go into synergic contraction, while strong extension of the fingers brings the flexors of the wrist into similar action. Yet how often are finger exercises, and especially toe exercises, neglected altogether, or the plaster so badly cut that they are impossible? A very important point in these exercises is that they must be done strongly—gentle ladylike movements produce little synergic effect.

2. In a fractured femur the position is reversed. The ankle is free to move, though out of functional use, while

FIG. 1.—“Rehabilitation starts on the first day of treatment.”

the quadriceps is only free to perform "static" contractions. These, however, must be done with the greatest regularity throughout the period of immobilization from the third week onwards. In regard to the "defunctioned" ankle-joint, this should not only be exercised through a full range of movement but it should be exercised against resistances comparable to weight-bearing stresses, thereby treating the leg muscles as one does the quadriceps in a "walking-plaster." Many textbooks on fractures still reproduce photographs showing methods of supporting the ankle-joint in fixed dorsiflexion on a Thomas splint. This is entirely wrong. It should be free to move all the time, but its position of rest should be that of dorsiflexion. The simplest and most effective method of doing this is shown in Fig. 1: the weight in the bag is gradually increased so that during the whole period of splint treatment the patient is practising graduated resistance exercises for the calf muscles. No patient treated for fractured femur should ever have the slightest difficulty afterwards in regard to either the ankle-joint or the calf muscles.

3. In hyperflexion fractures of the spine conservation of function in the extensor muscles of the back is of paramount importance. Ankylosis in bad position gives a perfect functional result provided the muscles recover, but failure of these to recover always results in partial disablement for heavy work, however good the reduction and consolidation of the fracture.

These and similar measures for the conservation of muscle function require a great deal of co-operation on the part of the patient, and the surgeon or some responsible member of the fracture clinic team must be prepared to ensure that it is forthcoming. Ignorance, stupidity, apathy, and sheer laziness must all be overcome. In a fracture ward there are always a few good "workers" who can be disposed at strategic points where their influence and example will spread to less determined patients. Another asset is a ward sister who is more concerned with seeing that exercises are carried out than with keeping the bedclothes tidy. In out-patient cases instructional exercise classes must be held for those in plaster, and these patients must be thoroughly impressed with the necessity for carrying out their exercises assiduously at home. In fact, the more experience one gains in dealing with the later stage of rehabilitation the more one is impressed with the importance of these earlier measures. With good muscle recovery and an imperfect radiographic result there is always hope of complete functional recovery; but even if this does not materialize, operative correction still offers a chance of completely retrieving the situation provided muscle power is conserved. On the other hand, perfect radiographic results combined with atrophied fibrotic muscles end in disability that is permanent and irretrievable. It is no satisfaction to a working-man who cannot earn his living to know that his radiographs are being used to demonstrate the principles of accurate reduction.

Power and Mobility

At the Miners' Rehabilitation Centre the more one analyses disability the more one becomes convinced that the key to success is restoration of muscle power. Mobility is an advantage only in proportion to the power of the muscles to control it under the conditions of stress normally encountered at work. One has to think of pushing tubs of coal rather than in terms of walking across a floor. Muscles have two functions in regard to joints—they supply motive power in one direction and act as shock-absorbers and stabilizers in the other. This shock-absorbing mechanism is of great importance to miners and other working-men whose joints are subjected to great strain. If it is deficient the joint "gives way" under stress and a mild sprain is produced. Repeated traumata of this kind lead to chronic synovitis or even arthritis, which in their turn exert an inhibitory effect on

the muscles so that a vicious circle is set up. That is why a patient who returns to heavy work with weak quadriceps complains that his knee swells at the end of the day and his leg does not get any stronger in spite of active use. It is also why traumatic arthritis is progressive, and the only rational treatment of the latter, therefore, is to strengthen the muscles that exercise a protective action on the damaged joint.

To a miner diminished mobility with full muscle power gives a much better functional result than full mobility with diminished muscle power. I have seen several instances of men with only 45 degrees of movement at the elbow-joint doing full work at the coal face while other men with 120 degrees of movement were unable to do so. Mobility, therefore, is not always an end in itself, and if muscles already weak have to be stretched in order to produce it, as in manipulative treatment they often are, the patient may be better off without the extra mobility.

Muscle-efficiency Tests

It is obvious that if muscle power is the key to success some method of measuring it must be adopted so that the value of different kinds of treatment may be assessed. This is done at Berry Hill Hall by expressing the power of a particular group of muscles as a fraction of the sound side. In the case of the extensor muscles of the back, which cannot be expressed in this way, a known standard is determined by testing normal subjects. The apparatus necessary to determine muscle efficiency is a system of pulleys and weights designed so that any desired movement can be isolated and performed against measured resistances. In the quadriceps extensor group, for example, the method employed is to load the sound leg till its "exercise tolerance" is reached. By this is meant the greatest weight that can be raised fifteen to twenty times in succession as an exercise. The same procedure is then repeated on the injured leg, and the result expressed as a fraction (e.g., $\frac{R}{L} = \frac{12}{25}$).

These muscle-efficiency tests have been carried out in a great many conditions, and the results are very instructive. For example, in compression fractures of the spine treated by reduction and ambulatory plaster for four to six months the efficiency of the extensors of the back is often as low as 20% after removing the plaster. This is so in patients who have done exercises throughout the period of immobilization. The results of these muscle-efficiency tests are charted week by week in the form of a graph, and constitute a very reliable guide to progress and to the value of different methods of treatment (Fig. 2).

It becomes obvious at once why it is better to recover joint mobility by active movements alone. To do so ensures that muscle power increases with the mobility, so that the joint never recovers more movement than can be controlled under stress. In the great majority of cases stiffness after fractures is due to fibrosis in the muscles, and if such cases are manipulated any increased movement obtained is at the expense of tearing and stretching the fibrosed muscles. The charts of such cases reveal an immediate drop in muscle efficiency—often as much as 50%.

Manipulation should be avoided as far as possible, therefore, in those cases in which stiffness is due to

FIG. 2. — Muscle-efficiency chart. Quadriceps extensor group in a case of fracture of shaft of femur.

muscle fibrosis. Sometimes it has to be resorted to because the degree of stiffness is outside the limits of functional usefulness at work, and then the golden rule is to do a little at a time and repeat it every few weeks. If this is done the depression of muscle efficiency is minimal and the pre-manipulative level can be regained in a week or two. During the intervals the stretched muscles are treated daily. This treatment consists of active exercises to the limit of tolerance, deep massage to painful areas, and surging faradism. There is a second type of stiffness due to fibrosis and contracture in ligamentous or capsular structures, and this responds well to a full manipulation. The muscle efficiency in these cases is not depressed by the manipulation, and subsequent recovery is dramatic.

The Analysis of Functional Disability

The first essential in rehabilitation is an accurate analysis of the disability. The patient does not tell the surgeon which muscles are at fault; he expresses the disability in terms of function, and says what he cannot do or what he finds difficult or painful. In leg, back, and pelvic cases there is nearly always some disturbance of gait to analyse as well. Good analysis depends on a knowledge of the anatomy of function, which is not the way we learn anatomy. We are taught the action of isolated muscles instead of the muscle work of purposive movements such as walking, lifting, pushing, and so on. Yet without this knowledge it is impossible to analyse faulty gaits, obscure aches and pains, and difficulty in performing certain everyday acts. Still more impossible is it to analyse difficulty in performing complicated movements encountered in the course of heavy work. A patient may say, for example, that he can walk all right on the flat but finds difficulty in walking downstairs. This is common in quadriceps cases and is simply a question of mechanics. When the whole body weight is on one leg, the more the knee-joint flexes the more power is required on the part of the quadriceps to stabilize it, just as the load on an engine pulling a train round a curve is very much greater than when it pulls the same train along a straight track.

Lifting weights off the ground, which is vitally important to miners, is chiefly a gluteal action extending the hip-joints, but the spine must be fixed in relation to the pelvic girdle by a powerful static contraction of the sacrospinalis muscles. It is failure of the latter that prevents miners from doing heavy work at the coal-face after a compression fracture of the spine; but the same functional disability might be due to a myofascial sprain of the gluteus maximus. All the miner knows is that he cannot lift the sort of weights he is called on to lift at work, and that efforts to do so are painful. Intelligent rehabilitation therefore depends on good analysis of

functional disability, which in its turn depends on a knowledge of the anatomy of function and of the effects of trauma on soft tissues.

Remedial Exercises

Having analysed functional disability on these lines, what is the remedy? What, in other words, is the secret of redeveloping weak muscles? The answer is that it can only be done by the unremitting efforts of the patient himself. Muscles hypertrophy only in proportion to the demands made upon them day after day and week after week. That is why professional footballers have such magnificent quadriceps, though their arm muscles may be quite ordinary. Exercises must therefore fulfil two conditions: they must be specific for the muscles concerned, and they must be progressive. The principle of progression is of the utmost importance in rehabilitation, whether in relation to remedial exercises, occupational therapy, or games. Remedial exercises constitute the

backbone of treatment, but they can only succeed if certain conditions are fulfilled. They must be performed day in and day out *ad nauseam*; they must be performed against gradually increasing resistances, and the periods of exercise must be correctly spaced with periods of rest so as not to induce undue fatigue. They fail in most cases because none of these conditions is fulfilled. The out-patient who attends an exercise class three

FIG. 3.—Mobility exercises: the auto-assistance principle.

times a week is rarely treated as an individual. He is a member of a "class" for back or leg or arm cases, and does the same exercises without progression from start to finish. Moreover, he seldom exercises during the intervening periods, through lack of instruction to do so, lack of self-discipline, or gradually increasing apathy as his disability drags on.

At the Miners' Rehabilitation Centre remedial exercises are carried out in the gymnasium for two periods of an hour and a half each day. They are arranged into a series of progressive schemes for each type of case, and are under expert supervision. In a back case, for example, there are four schemes, and it takes the average patient eight weeks to work through them. It is outside the scope of this paper to describe remedial exercises in detail, but one or two points are worth special mention. The first is in regard to a type of assisted active movement in which the patient himself provides the assistance with the opposite limb. It is illustrated below for flexion of the knee (Fig. 3). This type of mobility exercise is specially useful (a) when unassisted active movement is painful (this is frequently the case in shoulder injuries, or after a manipulation); and (b) when unassisted active movement is not powerful enough to make any headway

against the resistance imposed by the fibrosed structures causing the stiffness.

I know that passive movements are nowadays condemned, but many of these patients would never make any headway without some assistance. I differentiate between passive movements and assisted active movements, however, and, provided the assistance is given by the patient, it can do nothing but good. Relaxation of the opposing muscles is the crux of the matter, and to obtain this the patient must have perfect confidence. If a second person is providing the assistance the patient instinctively puts the brake on long before the limit of tolerance is reached, because any other method of informing the operator that he is approaching this point would be too slow to act in time. With the patient himself in control, however, perfect relaxation is possible right up to the full limit.

The second point is in regard to graduated resistance exercises, which are extensively used for selective strengthening. The principle is best illustrated by the hypertrophy of involuntary muscle. If the intestines or the bladder have to work against a gradually increasing obstruction they invariably hypertrophy—often to a remarkable degree. The two factors which produce this hypertrophy are a gradually increasing resistance and a muscle acting almost continuously in an effort to overcome it. If the load is increased too suddenly, however, failure occurs. These factors apply equally to voluntary muscle, and the more difficult the case the more gradual must be the progression. The muscle-efficiency chart is the real index of progress.

To give graduated resistance exercises the same pulley-and-weight apparatus described earlier for measuring muscle efficiency is used. It can be applied to any muscle group in the body, but to illustrate the method the quadriceps extensor group will be used as an example. First of all the exercise tolerance of the affected muscle is determined—that is, the greatest weight the patient can raise with his quadriceps fifteen to twenty times in succession. At regular intervals, depending on the individual factors, half a pound is added, often without the patient's knowledge. He can work with these maximum loads for only very short spells, so the method followed is to intersperse these with more prolonged exercises against 50% of the maximum load. By this method satisfying results have been achieved in the most unpromising cases. As an example, it has been found possible to increase the quadriceps efficiency from 4 lb. to 26 lb. (normal leg, 32 lb.) in an old-standing case of a man who had been off work for two years following a knee injury.

Accessory Methods

The other forms of treatment used, which make up the rest of the six-hour day, are occupational therapy, physiotherapy, and remedial games. These are accessory methods, however, and it is fallacious to think of rehabilitation entirely in terms of one or the other, as a good many people nowadays do. Indeed, this seems to be the official conception of rehabilitation. At Berry Hill Hall we rely on remedial exercises to gain ground, and on occupational therapy and remedial games to consolidate it. The idea of adding creative interest on the one hand or competitive interest on the other is very sound and attractive, provided such ideas are not allowed to become a hobby-horse and obscure the essentials underlying them. The weakness of both is that neither the principle of selectivity nor the principle of progression can be so scientifically applied. Furthermore, none of the forms of occupational therapy in standard use would get a miner anywhere near the stage of full work.

Occupational Therapy.—It is impossible in the limits of this paper to deal in detail with the application of occupational therapy or remedial games to particular injuries, but a brief description of both as organized in a rehabilitation centre may indicate their general usefulness. Occupational therapy is divided into indoor and outdoor work. The men at Berry Hill Hall assist in the laundry and do all the domestic cleaning in the gymnasium. In the craft-room the hand and arm cases are taught to make wicker-work baskets, trays, and stools, and leg cases to do treadle work. The remedial workshop is equipped for simple carpentry, and a miniature conveyer-belt has been installed which gives the back cases an opportunity of practising the movements and experiencing the stresses peculiar to their own work, but under controlled and progressive conditions. The belt runs over spindles operated by cranks, and motive power is provided by the advanced arm and shoulder cases. The action is like that of turning a mangle, but it is a progression on laundry-work. Logs of wood weighing from 10 lb. to 80 lb. are used instead of coal. Outside in the grounds of the estate there are gardening, timber-work (tree-felling, log-sawing, etc.), and the care of lawns, cricket pitch, tennis court, bowling green, etc. Each patient is scheduled to a class of work suitable for his injury, and as he makes progress in his gymnasium work he is correspondingly advanced in occupational therapy.

In addition to these forms of occupational therapy, some of which (e.g., timber-work) are quite heavy, I am able to use the enormous resources of the industry in placing men at a variety of jobs in the pits which can be used as a very advanced form of occupational therapy. Most back cases, for example, are sent to a period of "datalling" work, which involves a good deal of walking, bending, shovelling, and lifting, but allows the workman to pause occasionally between efforts instead of going "all out" all the time, as he would have to do at the coal-face. A knowledge of industrial processes is needed to place men properly if light work is to be successfully used as a remedial agent, and it is necessary to keep contact with such cases. Periodic re-examinations are therefore made till they either resume full work or have otherwise reached the limits of progress and been placed in the class of permanent light work most suitable for them.

Recreational Activity.—This also takes indoor and outdoor forms. Many games can be played in the gymnasium, but there is much more scope in the open air. Games such as badminton, bowls, croquet, etc., are played for amusement after the day's treatment has finished. During the official games period, however, the men are supervised in their activities and the games are more adapted and remedial. Back cases do particularly well on games like basket ball and tunnel ball. Leg cases, however, have to be carefully watched if they are allowed to play running games, otherwise a considerable number of sprains will be incurred, especially if there is a football about. This is because the muscles of these patients are not efficient enough to protect their joints against the sudden twists and strains of vigorous games. Leg cases are sent out in groups on bicycles, which is one of the most excellent of all forms of recreational activity, and many patients living within five miles or so of the centre cycle in every morning as part of their treatment. As in occupational therapy, recreational activity must also be progressive and adapted to the injury, and there is infinite scope for originality and ingenuity in the invention of new games to promote particular movements.

Physiotherapy.—Physiotherapy is confined to faradism and deep massage. The former is used as an auxiliary method of strengthening weak muscles; the latter in dealing with painful areas in muscles. These are quite

common following trauma, and they inhibit full active use of the muscle so that the patient is never able to get the maximum benefit from remedial exercises. They are due to localized fibrosis in areas to which traumatic exudates have gravitated. Deep massage is very effective, but it must be done properly—skin-stroking is useless. Preliminary injection with 2% procaine just below the muscle aponeurosis is helpful in many cases. Once the pain is abolished there is a dramatic increase in muscle power, showing that this was there all the time but was inhibited by the pain. In the analysis of disability referred to earlier it is important to distinguish this type of case from the one in which loss of power is due to atrophy alone, since the treatment is quite different.

Summary and Conclusion

In this paper the principles underlying the process of rehabilitation have been described. The final stages of this process are best carried out in special centres, but the earlier measures directed towards conservation of muscle function during immobilization are of equal importance.

The methods of treatment employed in a rehabilitation centre for injured miners are described. This centre was established by the employers of 100,000 workmen, the accident rate amongst whom is five times greater than the average accident rate in industry.

The only criterion by which success in rehabilitation can be judged is the patient's return to full pre-accident work and activity. Clinical attempts to assess this are unreliable. In a consecutive series of 1,200 patients treated in one year in the Mansfield Hospital Fracture Clinic, all of whom were miners injured at work, 87% resumed their full pre-accident occupation, and 9% resumed lighter work in the same industry. There was a mortality rate of 1%. In about 15% of the mining accidents dealt with in this clinic treatment is completed at the Miners' Rehabilitation Centre.

The Central Council for Health Education is able to command the services of some most talented people with the pen, pencil, and camera, and some of its leaflets, which are sold at production cost to local authorities and distributed in various ways by medical officers of health, are as telling as the very best commercial advertising. Three pictorial leaflets bearing the titles "Ears to Hear," "Eyes Right," and "Sleep" convey their message in a series of film-like pictures which make words largely unnecessary. A number of posters have also been brought out by the Central Council, and are so emphatic in their design and colour that he who runs may read. For those who may prefer to do their reading while not running there are a number of pamphlets on such subjects as the prevention of diphtheria, the war on lice, the elementary facts concerning milk, food, water, and sanitation, which lack nothing in the directness of the advice they give. A whole series of leaflets has been prompted by war conditions. Among them is a 16-page booklet on "Health in the Shelter," in which the clever levity of the drawings relieves the necessary seriousness of the text. It is the aim of the council to secure that every possible subject connected with health on which the public ought to be informed shall be illustrated by a popular leaflet or pamphlet. The war has opened up quite a number of new subjects, of which "Health in the Black-out," the title of a new leaflet, is one. The attractive booklet, "The Doctors tell you what to eat in Wartime," which was prepared by the British Medical Association at the request of the council, is another example of activity in this direction. It is suggested that some of these leaflets might be placed on the table in the waiting-rooms of medical practitioners. Medical practitioners, however much it may be against their mundane interests, are amongst the best apostles of preventive medicine, and we do not doubt that many of them will accept the invitation of the Central Council (whose address is Tavistock House, Tavistock Square, W.C.1) to have a free supply of this health publicity material sent to them for this purpose.

PULMONARY CONCUSSION ("BLAST")

BY

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"Every new ordeal to which the lung of man is exposed produces if not an entirely new lesion at least a new angle from which to study an old one."—LANCET.

"Pulmonary concussion" is a term which has been used for haemorrhagic lesions of the lungs resulting from the detonation of high explosive. Cases are recorded here which show that virtually the same syndrome can be brought about by the ordinary forces of civil life as by the action of bombs.

Experimental and theoretical considerations have now established beyond reasonable doubt that blast injuries of lungs are produced by the high-pressure wave of the blast acting for a short period; in other words, it is due to a sudden diffuse compression of the lungs through the chest and abdominal walls, and is typically unaccompanied by obvious injuries of the thoracic wall. "Diffuse" does not mean that the two lungs are equally affected, just as injury to the thoracic wall does not exclude the action of blast. A sudden diffuse compression of the lungs can readily be brought about by mechanical causes. More important under war conditions is the fact that the compression of blast and of mechanical forces frequently occur together. The most important difference between war and civil cases is the greater degree of violence in the former.

Comparison of Peace and War Injuries to the Lungs

I have notes of 94 necropsies made during the last three years on persons dying through road accidents. In reviewing these it is notable how many ribs may be fractured with no lung injury at all: 6 cases, all those of men between 58 and 69, had multiple rib fractures but no lung damage. Four more had multiple rib fractures and minor lacerations of the lungs from the rib ends, but no appreciable contusion of the lungs; these cases were those of a boy aged 13 and three men between 39 and 44. A man aged 21 showed lacerations and pulping of the lungs after an aeroplane crash. Three patients with fractures of the skull inhaled some blood; these were males aged 10, 13, and 19. Only 3 of the 94 had lung lesions comparable to those of the bomb cases; these were in girls aged 4 and 8, and a boy of 7. The best example is a girl of 4. A motor-lorry had run over her and caused a fracture-dislocation of the sixth and seventh cervical vertebrae, but no fracture of or external mark on the trunk. Her lungs showed multiple haemorrhages, which all appeared on the pleural surface; they were most numerous in the parts of the lungs which enter the phrenico-costal sinus of the pleura and posteriorly, but there was some rib marking on the lateral surfaces. The liver showed a small laceration of the posterior surface and there were some peritoneal tears in the transverse colon. The girl of 8 had been knocked down by a motor-car; she showed a little bruising over the left lower ribs but was otherwise unmarked; the ribs were not fractured. There was a haemothorax of nearly two pints on the left and a smaller one on the right. There was a large tear near the hilus of the left lung, and contusions were scattered fairly generally throughout both lungs. The liver was torn but the spleen was not. The boy of 7 was run over by a motor-lorry. He sustained an extensive fracture of the skull with brain injury. The trunk was not marked. The left lung showed a widespread haemorrhagic lesion about the hilus posteriorly, "rib markings" extending about three-