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The Physiologic Basis of Rest as a Therapeutic Measure in Pulmonary Tuberculosis[1]

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PHYSIOLOGY OF REST AND EXERCISE

THE physiologic principles which underlie the treatment of pulmonary tuberculosis by rest are the same as those which underlie the treatment of any disease by this measure. Innumerable remedies have been suggested for the treatment of tuberculosis, but only a few have established themselves as being able to produce outstanding and permanent benefit; of these, rest unquestionably holds first place.

There is no such thing as absolute rest for the human organism. Rest, as we know it, is but a relative degree of exercise. The body may be divided into the somatic or skeletal and the visceral systems. The somatic is under control of the will. The visceral system is not under direct control of the will. It is made up of the vegetative structures upon which the life processes themselves depend. We cannot rest the vegetative or visceral system. It is active from birth until death. We can, however, reduce its activity to the lowest possible point. The voluntary system, on the other hand, can be largely put at rest. When we speak of rest, we mean a relative inactivity in the voluntary muscular system and a reduction of the demands upon the vegetative system to a low point.

Remembering that man is a dual organism, consisting of a psychical as well as a physical being, and realizing that physical activity can be materially enhanced or materially decreased by different psychical states, it is necessary to take the psychical state of the patient into consideration in dealing with this subject. Putting the patient in the best condition for the cure of his disease consists in bringing him to a state in which his physiologic balance is best preserved. Consequently, there are certain fundamental factors which must be considered, among which are relative rest both of the voluntary and vegetative systems when the disease is active; exercise suited to each patient's condition after activity has ceased; open air; good food; cheerful surroundings, a suitable psychic attitude, and guidance of the patient's whole life by one who understands tuberculosis and the tuberculous patient.

I shall endeavor to discuss the question of physical rest in such a manner

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as to show the difference in demands made upon the organism when the patient is at rest and when he is on exercise. These demands may be expressed not only in the work done but in terms of food and oxygen requirements and circulatory adjustments.

There is an increase in the blood-flow through the muscles and organs involved in work beyond that required at rest. In order to meet this increase in demands an extra amount of food, an extra amount of oxygen, and a hastening of the blood-stream must be brought about. This latter is met by both an increased rapidity of the heart's action and an increase of ventricular output on the part of the heart, and by a rise in blood-pressure. Among the chief factors that enter into the blood-pressure are the tone of the heart muscle, the resiliency of the blood vessels, the tone of the voluntary muscles and the suction of the inspiratory effort, which has a marked effect upon the return of the blood to the heart.

Preceding a discussion of this kind it must be made clear that physiologic balance is maintained with greater ease and greater efficiency under certain conditions than others. In conditions of health there is a great difference between the trained and the untrained, and there is a vast difference between those who are ill and those who are well. The patient suffering from active tuberculosis must be considered from the standpoint of one who is ill and untrained; consequently, he will maintain his balance with great difficulty, and this difficulty will increase as the body suffers more from the disease. Life as a whole consists of physiologic adjustment—the adjustment of the body to stimuli, either physiologic or pathologic—and this adjustment must take place regardless of the handicaps present or some function will suffer or even life itself may be extinguished.

Food requirements

The food requirements of the body depend upon the total amount of activity in the body cell. The waste must be eliminated and the normal cellular balance must be restored, or health will be impaired. It is estimated that from 1800 to 2000 calories of food per day are required at rest; from 2500 to 3000 during moderate work, and from 3000 to 5000 during hard work. The importance of carrying on the body functions with the least possible demands upon the organism in a disease like tuberculosis should be self-evident, because the patient is required to struggle against the disease over a prolonged period of time. A high state of nutrition is extremely important if the body cells are to oppose the infection in an advantageous manner. It takes 20 per cent more effort, which means 20 per cent more food, to sit quietly in a chair than it does to lie quietly on a couch; it requires 100 per cent more to walk around and 300 or 400 per cent more to do strenuous exercise. It is often difficult to meet the extra demands of exercise when the patient is suffering from active tuberculosis, because the appetite and digestive capacity are reduced and the normal cellular interchange is hampered.

Circulatory requirements

When an individual in health is at rest the pulse usually beats from 70 to 80 times per minute; on moderate exercise it increases to 100 or 120, and on strenuous exercise to 150, 200, or even more. It is also necessary for the blood-pressure to rise from 50 to 60 mm. of mercury in order to maintain the supply of oxygen and food necessary for the tissues. The heart output per minute, at rest, is 4 or 5 liters, while during work it may run up as high as 20 or more liters. The voluntary muscles at rest are traversed by about one-third of the body blood, or 1.66 liters per minute. Upon exercise this may be increased to as high as 14 or 15 liters per minute, showing that even an eight-fold increase may be required to take care of the extra exercise.

These circulatory adjustments are absolutely essential to the life and activity of the cells; and, if conditions are present which interfere with their accomplishment, inefficiency or even inability of physiologic adjustment will result. The difference between the trained and untrained man is shown by the fact that in physiologic experiments the blood-flow through the muscles is increased during hard work by those who are trained from 4 to 9 times, while in the untrained it would only be increased from 3 to 6 times; and further by the fact that while the trained individual responds with a relative increase in pulse rate but a marked increase in ventricular output, the untrained responds with marked increase in pulse rate and only a relative increase in the output of the heart, the latter being a condition which favors inefficiency. This shows the handicap of the untrained individual as far as his circulatory mechanism is concerned. The patient with active tuberculosis not only belongs to the untrained class, but further suffers from the effects of toxins upon his body cells which reduce efficiency of physiologic response much more than is the case in those ordinarily classed as untrained.

The total work of the heart in maintaining the circulation of the body while the patient is at rest is equivalent to raising a ton weight 122 feet per day. On moderate exercise—such as is equivalent to a walk of four miles per hour—this is raised four-fold, and upon severe exercise, it is increased even much beyond this.

Oxygen requirements

When an individual is at rest he requires from 250 to 300 cc. of oxygen per minute; on moderate work from 600 to 1600; and on hard work from 1750 to 2100, and on severe exertion such as an hundred-yard dash, the amount may be increased to 150 liters.

Nervous correlation in exercise

The efficiency of exercise not only depends upon the food intake, the oxygen consumption and the circulatory efficiency, but also depends very largely upon the efficiency of the nervous system. We must never lose sight of the fact that efficient action consists of a correlation of nerve with muscular activity. In the patient suffering from active tuberculosis neither muscular nor nervous system is efficient; consequently, he has a bad correlation and works at a great disadvantage.

NECESSITY OF REST WHEN DISEASE IS ACTIVE

In order to apply most effectively the physiologic principles heretofore discussed, it is necessary to consider the tuberculous patient as being one who suffers from toxemia at certain times and who is free from toxemia at other times, but one who has during the entire time that the disease is present an important organ inflamed which presents conditions favorable to harmful reflex stimulation of other organs and tissues connected with it. Other things being equal, the efficiency of the physiologic response of the patient will differ according to the manner in which the toxins influence his body cells. The efficiency of his physiologic response consequently varies with the degree of toxemia present. When the patient is generating in his body a sufficient number of toxins to interfere with his normal physiologic response, the amount of exercise which he takes should be reduced to the minimum. Consequently, rest is the important measure to be utilized when the patient is suffering from active tuberculosis. In order to emphasize this statement it is only necessary to call to mind the common symptoms which are present during the active stage of the disease and which are increased with exercise. In the first place the nervous system is rendered more irritable and less efficient; the entire muscular system, including that of the heart is weakened; all tissues of the body show more or less loss of tone; the blood-pressure falls; digestion becomes impaired; the gaseous exchange of the cells themselves is retarded, and the chemical and physical reactions of the cells are altered. The effect of these changes upon the defensive mechanism of the body is serious in proportion to its magnitude.

If we have a deficient oxygenation, there is a lessening of the normal alkalinity of the tissues which manifests itself particularly in the foci of disease. This condition is particularly favored by the lessened circulatory efficiency. These conditions are favorable to action of harmful enzymes in their destructive process upon the injured cells. Consequently, an amount of exertion which is beyond the ability of the patient to measure up to and still preserve his normal physiologic action injures the body cells as a whole and favors caseation and destruction in tuberculous foci.

The chain of symptoms which is recognized as belonging to the toxic group—malaise, loss of endurance and strength, nerve irritability, insomnia, indigestion, rapid heart action, shortness of breath, increased temperature—often follows closely on an undue amount of exercise, during the active stage of the disease. Furthermore, most of these are improved and many of them eliminated by rest.

Exertion during activity also increases the amount of coughing, and this of itself often proves to be very deleterious. The coughing effort alone in patients at times amounts to a considerable degree of exercise. It has been roughly estimated that a person doing severe coughing may perform an amount of work equivalent to walking a mile or two per day. Rest is one of the most potent remedies for the reduction of useless cough; exercise, on the other hand, is one of the most common causes for increasing it.

I have no hesitancy in saying that unwarranted exercise has been the immediate cause of hastening death more often and the actual cause of more deaths from tuberculosis than any other one factor. The degree of exercise which is permissible varies with different clinical forms of the disease and the physical state of the individual. The amount of exercise permissible is that which is always within the physiologic demands of the patient. Some individuals can exercise and still get well. The explanation of this is perfectly simple; it means that they can maintain a physiologic equilibrium sufficient to overcome the disease, regardless of the amount of exercise that they take. A patient can get well quickest, however, if he will keep the amount of exercise within his balance of energy formation.

NECESSITY OF EXERCISE WHEN DISEASE IS QUIESCENT

While rest is essential during the active stage of the disease, exercise is just as essential when activity is passed. We must never lose sight of the fact that a certain amount of activity in muscle is conducive to its best physiologic state. Consequently, after the period of activity is passed, if there are no other contraindications, the patient's muscle tone should be built up and his general strength increased to as high a degree of efficiency as possible. The patient who is kept at bed rest during the period of active tuberculosis should have his physical powers raised to such a point that he can walk four or five miles a day without tiring after the disease becomes quiescent, and before he is considered fit to relinquish close medical supervision.

PRINCIPLES DETERMINING APPLICATION OF REST AND EXERCISE

In observing the general care of patients as carried on both in and out of institutions, I find a woeful disregard shown for the physiologic principles herein described. I often find patients exercising when the disease is active. I furthermore find certain ones who should be on exercise remaining at rest over prolonged and unnecessary periods.

The principles which should guide are not difficult to understand, although the indications for their application require considerable thought and study of each individual patient. There is really no definite method of determining when rest should be given up and exercise instituted that is applicable in all cases. It depends upon the ability of the physician to judge the condition of the patient. It does not depend upon temperature. Temperature was formerly and still is today too generally made the guide as to the presence of activity in tuberculosis. It does not depend upon the cough or the expectoration. But with experience one will eventually learn the value of many specific or general conditions upon the presence or absence of which in a given case he is able to determine fairly accurately the degree of activity present. His conception must take into consideration the fact that tuberculosis is a long drawn-out chronic disease, presenting recurrent periods when the active and inflammatory reaction is greater. The disease between the periods of activity is not healed, nor

is activity absent; it is only lessened in degree. The degree of activity in cases of this kind can be greatly magnified by exercise, or can be kept at a low level by rest. It has been my observation that patients who are in this state, if permitted to be on exercise, will nearly always cause more or less softening and breaking down and more or less extension of their disease; on the other hand, if kept at rest, they will nearly always reduce the amount of breaking to a minimum and in many instances bring about a rapid cessation of all active symptoms.

As regards the temperature in tuberculosis, it must be understood that it frequently goes in waves. For a few days it will be higher than normal, and this is followed by a remission which is again followed by elevation, and so on. These elevations, in a very common type of the disease, appear about every two weeks. Another type of temperature is one in which a rise will only come now and then, every three or four weeks, or every six weeks, or at longer intervals. A third type is the one in which the temperature reaches a daily maximum probably 1° to 3° above normal and continues for weeks or even months. The first two types are those that seem to be least understood by physicians. When patients are only seen infrequently, should they be seen during the periods of remission they will be considered as having inactive tuberculosis; while if seen during the periods of elevation, they will be considered as having active disease. A knowledge of the clinical course of tuberculosis, with a careful study of the patient and a fair ability at physical examination, will give a dependable basis upon which to prescribe rest and exercise.

Toxemia and temperature must not be taken as synonymous terms. Early clinical tuberculosis, with small circumscribed lesions, will not give a marked toxemia; but exercise beyond the patient's physiologic balance will often bring about increased activity with symptoms of toxemia and necrosis in the focus, with spread to other tissues.

I personally believe that even early cases of tuberculosis should be treated by rest—not rest for a definite period—but rest until the chances of the focus going on to a destructive process have passed. I dislike attempts at standardization, because as long as we are dealing with human beings we cannot standardize. We are dealing with individuals with different capabilities and different powers of reacting and withstanding harmful influences; consequently, we must adjust every measure that requires body adjustment to the reacting capabilities of the patient. Roughly speaking, however, I would say that about three months of bed-rest is the amount required for the average early case of tuberculosis. The amount required for advanced and far-advanced cases is relatively more. I have seen many patients remain at rest from six months to a year or more, and by so doing bring about a cessation of activity in a process which under all ordinary circumstances would have gone on to destruction long before.

I have been gradually increasing the strictness with which rest is applied in my practice, and since

doing so it is the universal observation of those who work with me that our results have improved. In early cases of tuberculosis, I have no hesitancy in saying that practically all can get well. We have just finished a term of eleven years, during which time we have not failed to bring about an arrestment of the process in a single early stage case that remained under treatment for a minimum period of six months; and we believe that our application of rest and exercise according to the stage of the disease and the patient's powers of reaction has been a large factor in producing such results.

In advanced cases the patient should be kept at rest until in the physician's opinion he can meet the extra demands that are made upon his energy without showing symptoms of toxemia, such as malaise, tiring and shortness of breath. When such a time has arrived the patient's general appearance changes as a rule. I do not refer to fatness, for the patient will usually put on weight during the early period of rest treatment; but I refer to a general appearance of good health. The patient loses his sick appearance; no longer appears toxic; does not show circulatory embarrassment; his skin becomes clearer; his expression becomes one of ease and comfort; he becomes less nervous; does not manifest the urge which is brought on by slight toxemia, and consequently assumes a more placid state. This condition will usually come about before the patient should be put on exercise.

THE TECHNIQUE OF APPLYING REST AND EXERCISE

Technique is just as important in using such simple measures as rest and exercise in the treatment of tuberculosis as it is in performing surgical operations; in fact, the success depends upon the technique employed. It is not sufficient in dealing with measures of this type to tell the patient to rest or to exercise. He must be told how to rest; how much to rest; when to exercise and how much exercise to take.

The bed-rest as employed in early tuberculosis consists in lying flat in bed for the greater part of the day. Patients whose disease is not very severe may be permitted to sit up during their meals and to take care of their toilet. They may also lie supported with pillows for a short portion of the time each day. They may read or write, or sew or knit, or do little things requiring a small amount of strength for a short period each day; but all such work should be carried out in such a way as to avoid tiring. I usually tell my patients to do these various things for ten or fifteen minutes, and then rest for ten or fifteen minutes, during a period of an hour or two, but never permit themselves to become tired. If the disease is more active and the tax upon the patient is greater, then he should not be permitted to get up even for his meals or for his toilet.

I have never employed as a general routine the extreme rest where a patient is not permitted to move his limbs or his body in bed. I have always felt that a little liberty made the routine easier and produced a psychical effect of great importance. As activity disappears and quiescence approaches, then the liberties allowed the patient can be gradually increased.

When the time for exercise has come, it should be begun very cautiously.

I always have my patients measure their sitting up by time, but when it comes to walking I employ distance instead of time as the measure. I have never felt that the method of telling a patient to exercise so many minutes was as good as telling him to walk so far. One patient will walk a mile or more in fifteen minutes, while another one will walk only a few hundred feet.

The method which I employ is at first to let the patient sit up ten minutes a day and allow him to increase the time ten minutes each day until he sits up with perfect comfort for three hours. Patients who have been in bed a long time may not be able to increase ten minutes every day without tiring, so when they arrive at a half hour, an hour, and two hours, they hold this time for a number of days until they do it with ease. During this period the patient is reëstablishing the correlation between his nervous and muscular systems, which has been disturbed more or less as may be judged by the degree of loss of efficiency. A definite program should be prescribed so that he does not push on too fast. After sitting up three hours with comfort, exercise is begun. At first the patient is allowed to increase his walking 100 feet each day. After he has attained one or two miles, this can be increased to 200 feet or even more, but the important point is to always keep the patient within the amount of exercise that he can do without fatigue. If the patient comes back from his walk tired and does not rest within an hour, this should be taken as an indication that he is overdoing. A healthy tire is all right, but if it requires much more than a half hour's rest to restore the normal, it is a sign that the exercise is too much. Loss of weight should also be considered as a probable indication of overdoing.