Chronic Bronchitis and Pulmonary Emphysema

The Application of Physical Medicine and Rehabilitation

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Chronic Bronchitis and Pulmonary Emphysema

Rehabilitation Manual

*Based on Part II of the Motion Picture,
"Chronic Bronchitis and Pulmonary Emphysema, The Application of Physical Medicine and Rehabilitation"*

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Public Health Service
Bureau of Disease Prevention and Environmental Control
National Center for Chronic Disease Control
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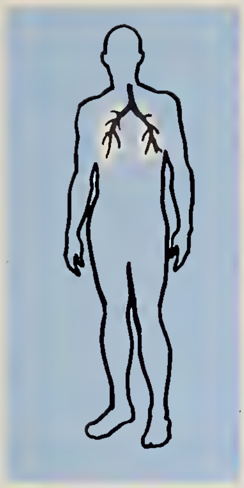


Foreword

Chronic respiratory diseases, of which emphysema and chronic bronchitis are primary examples, constitute the fastest growing health menaces faced by the medical community and the citizens of the U.S. Since causes have not yet been specifically pin-pointed, primary prevention of these diseases remains a distant goal. Studies have shown, however, that the proper treatment can add years of fruitful life to the thousands of victims of these crippling diseases, even those who have reached severe and advanced stages.

In recognition of the efficacy of proper detection, care and rehabilitation, the U.S. Public Health Service in 1965 established a Chronic Respiratory Diseases Control Program within its National Center for Chronic Disease Control. One of the earliest efforts of the new program was the production of a 1-hour, two-part motion picture, "Chronic Bronchitis and and Pulmonary Emphysema, The Application of Physical Medicine and Rehabilitation," on which this booklet is based. Produced in collaboration with the New York University Institute of Physical Medicine and Rehabilitation, the movie was designed to instruct medical and other personnel in the proper rehabilitation techniques for respiratory cripples.

This booklet is intended to supplement the motion picture by serving as a discussion guide and reference manual on the essentials of respiratory rehabilitation. Through this booklet, the Chronic Respiratory Diseases Control Program aims to extend the temporal educational effect of the movie with a manual of the techniques described. However, the manual is complete enough to provide adequate information on optimum rehabilitative procedures.

The Chronic Respiratory Diseases Control Program is indebted to the New York Institute of Physical Medicine and Rehabilitation, particularly to Dr. Howard A. Rusk, Director; and to the advisors for the film, Dr. Albert Haas, Technical Advisor, and Dr. Edward H. Bergofsky, Consultant Physiologist. We are also grateful to the personnel of the Audiovisual Facility of the National Communicable Disease Center, Public Health Service, for the many hours spent in the preparation of the motion picture.

Clarence A. Imboden, Jr., M.D.
Chief, Chronic Respiratory Diseases Control Program

The Vital Statistics

Do you know that . . .

- well over a million people in the United States are crippled by chronic bronchitis or pulmonary emphysema?
- one decade has seen a startling rise of nearly 400% in deaths from bronchitis-emphysema?
- this alarming rate exceeds that of lung cancer and tuberculosis combined?
- according to recent Social Security disability pensions, pulmonary emphysema is second only to coronary disease in disabling the Nation's workers, incapacitating one out of every 14 between the ages of 40 and 65, the group most economically productive and stable, and disrupting over a million families, socially and economically?
- the Social Security disability allowances to respiratory cripples represent an annual outlay of approximately $90 million?

Common Therapeutic Measures . . .

Regardless of the severity of the disease, certain therapeutic measures have been commonly employed with patients.

- Expectorants help liquefy the tenacious secretions usually present in the bronchi and thereby facilitate their removal by coughing.
- Bronchodilators in their various oral and aerosol forms help increase the diameter of the air passages.
- Antibiotics may prevent or lessen the effects of respiratory infections. One of the worst hazards to an emphysematous patient is acute infection. Rapid deterioration of pulmonary function during an infection warrants the immediate use of antibiotics even when the criteria of the infection are not clear-cut. Recently several regimens of prophylactic antibiotic treatments have been experimentally applied—the treatments ranging from once a week to daily administrations. These methods hold promise of decreasing the number of pulmonary infections. However, resistant organisms and superimposed fungal infections are still threats.
- Respirators provide mechanical hyperventilation. This device is also used to deliver bronchodilators and detergents as aerosols.

How Effective Have These Measures Been?

These therapeutic measures have been used with varying degrees of effectiveness. However, all these treatments are basically symptomatic and of short duration and, with the possible exception of antibiotic therapy, extend little promise of restoring the patient to some form of self-help.

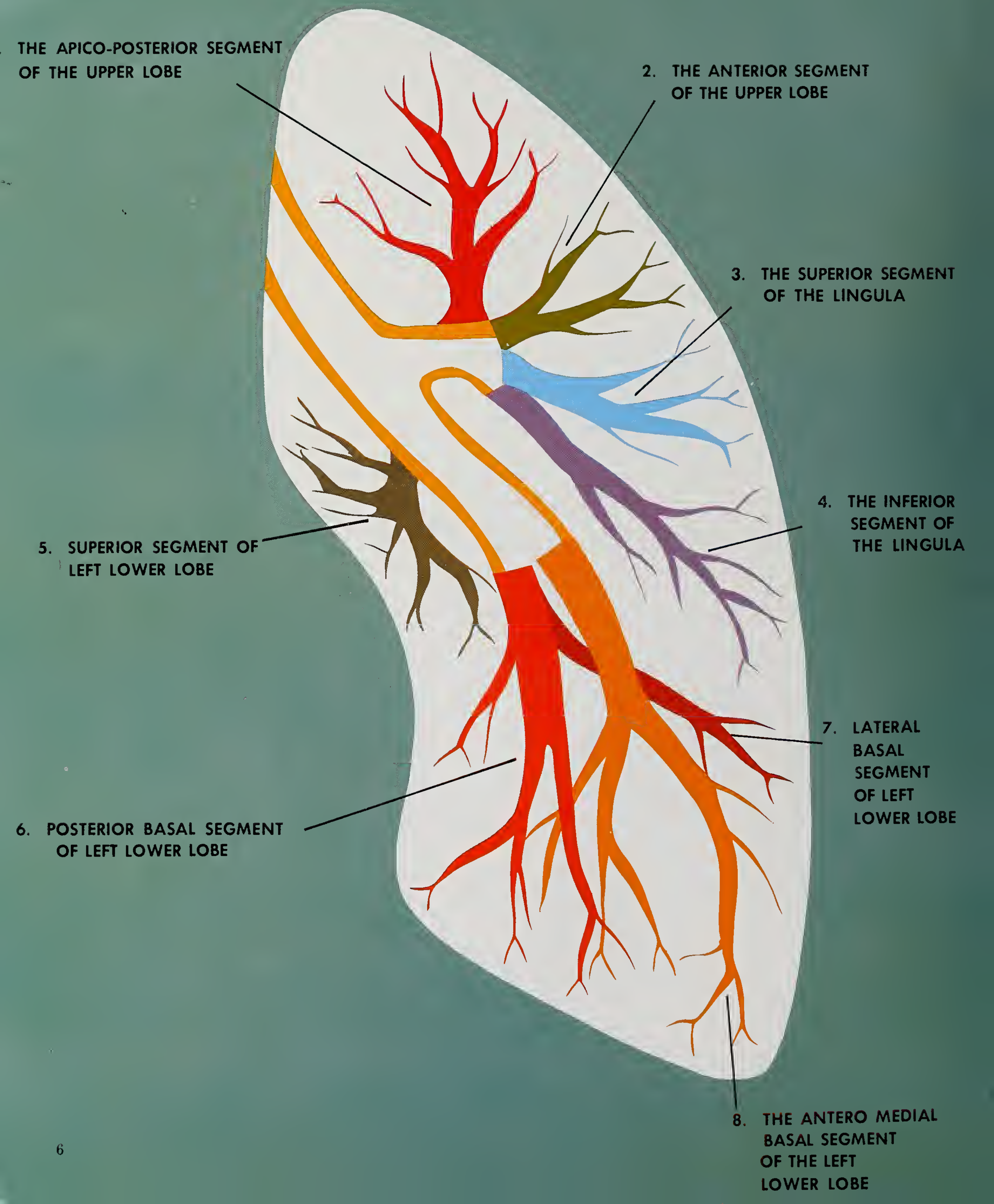
Pulmonary Emphysema . . .

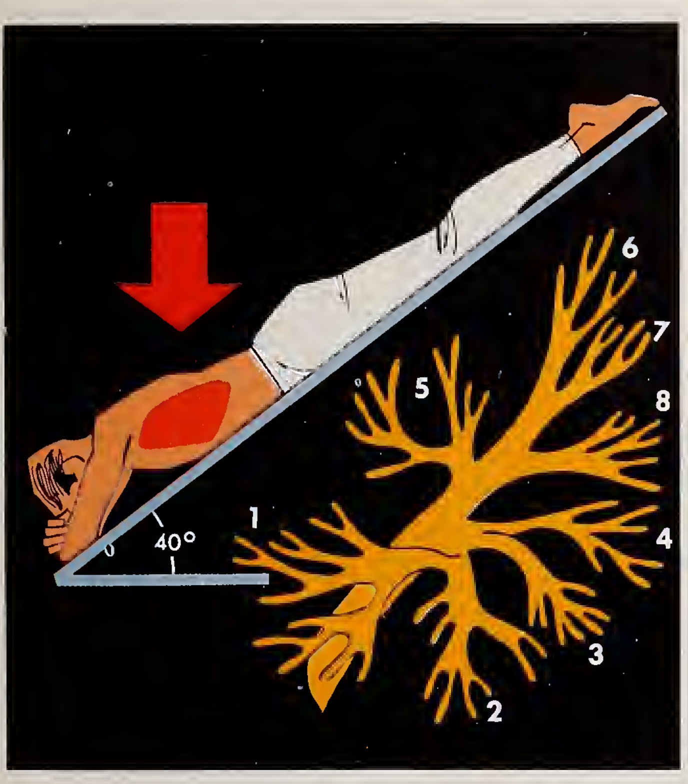
A 5-year study demonstrated that a rehabilitation program directed at retraining the respiratory muscles, with emphasis on postural drainage and breathing exercises, in conjunction with the usual clinical measures, was more effective than the therapeutic programs mentioned. Patients learned to live more adequately within the limits of their cardio-respiratory reserve for substantially longer periods and often engaged again in an appropriate kind of vocational activity.

Postural Drainage

To relieve obstruction in bronchi caused by accumulated secretions, postural drainage positions are ordinarily employed. Experience indicates that if the positions conform to the anatomic configuration of the bronchial tree, all parts of the lung can be successfully drained.

The Left Lung





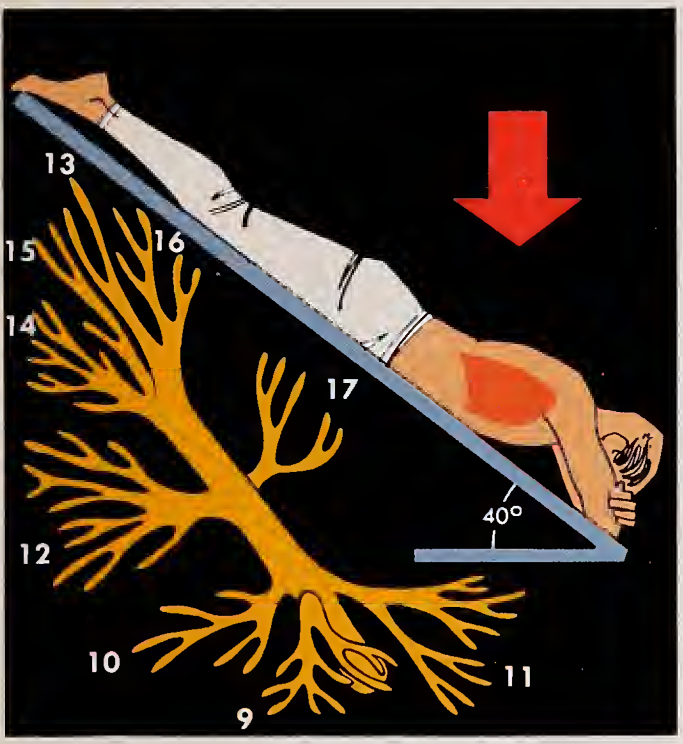
In the upright position, secretions from the upper lobe of the left lung: the apico-posterior segment of the left upper lobe (1), and the anterior segment of the left upper lobe (2), can be drained into the main bronchi and coughed up.

In order to drain the lower lobe of the left lung, the superior segment (5), the posterior basal segment (6), the lateral basal segment (7), and the anteromedial basal segment (8), gravity is brought into play.

While lying on his stomach, the patient is placed in a head down position at an angle of 40 degrees. This position will drain all of the segments of the left lower lobe except the anteromedial basal segment (8) and the lingula of the left upper lobe (3 and 4).

To drain the lingula (3 and 4) and the anteromedial basal segment of the left lower lobe (8) effectively, the patient must be placed in a different position. Here the patient lies on his back, in a head down position at a 40° angle. This position will drain the superior segment of the lingula (3), the inferior segment of the lingula (4), and the anteromedial basal segment of the left lower lobe (8).

The Right Lung



In the upright position the apical segment of the right upper lobe (9), and most of the posterior segment of the right upper lobe (10), drain spontaneously.

However, the anterior segment of the right upper lobe (11), the lower lobe and the middle lobe require special positions. In the first special position, the patient is placed in a 40°, head down position while lying on his stomach in order to drain the superior segment of the right lower lobe (12), the medial basal segment of the right lower lobe (13), the posterior basal segment of the right lower lobe (14), and the lateral basal segment of the right lower lobe (15). The middle lobe (17), and much of the anterior segments of the upper (11) and lower (16) lobes do not drain in this position.

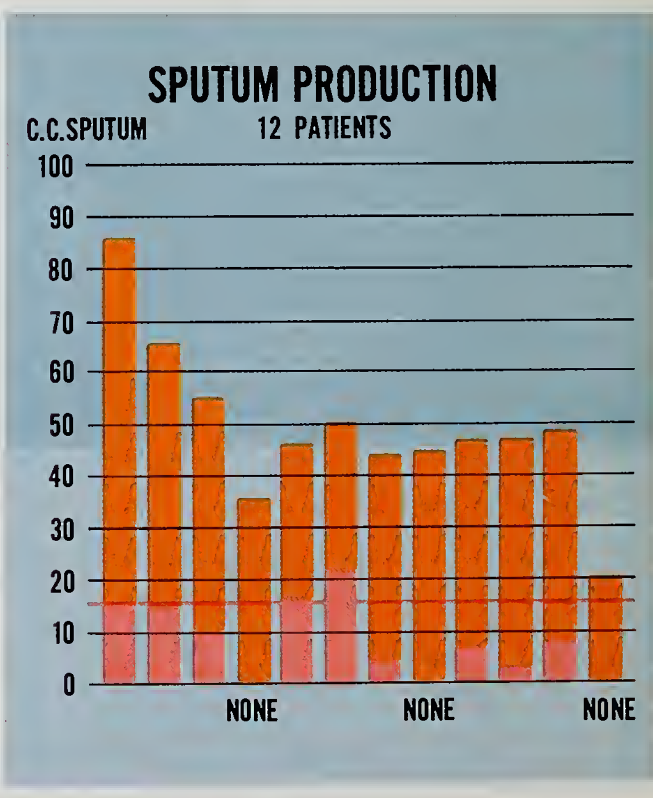
To drain these segments the patient lies in the 40° head down position on his back and inclined to the left.

To drain subsegmental bronchi the above basic positions require special variations. For example, when the patient is in an upright position, leaning first to the left, then to the right, and then leaning forward and backward, the drainage will be facilitated.

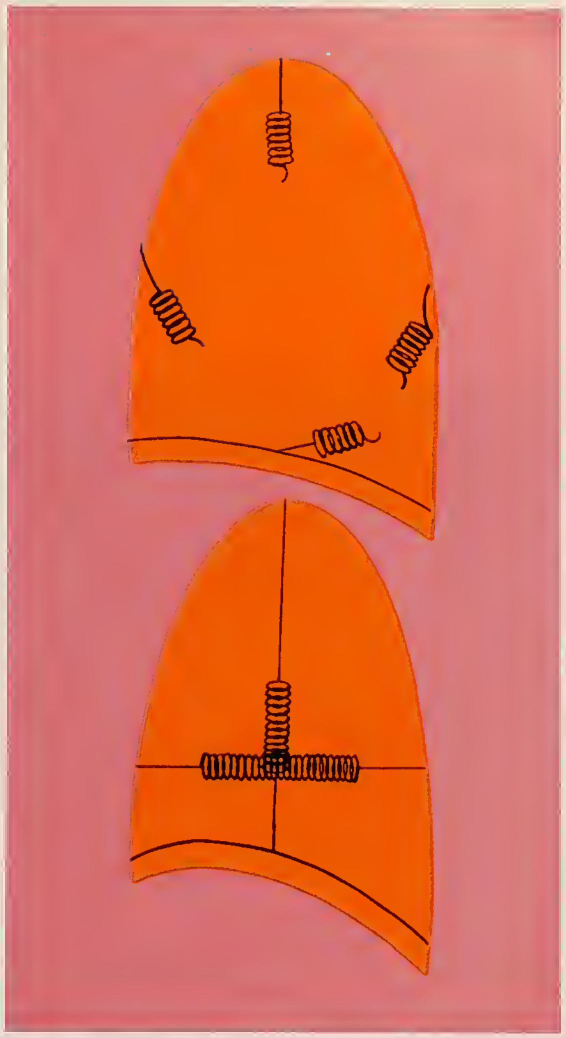
In the 40° head down position lying on his stomach, the patient rotates partially to the right and then partially to the left, holding each position for at least 30 seconds. Lying on his back in the 40° head down position, the patient then practices the same rotating maneuver. At the end of the exercises, to drain the lobar bronchi and trachea, the patient employs a 65° head down position for approximately 5 minutes. Tapping the chest over the affected segments along with rapid fire staccato-like coughing helps loosen secretions.

The procedures outlined above increase sputum production significantly. In a study of 12 patients suffering from emphysema or chronic bronchitis, before the practice of postural drainage, an average of 15 milliliters of sputum per day was observed. However, with postural drainage three times daily, sputum production increased to 40 milliliters a day.

The use of aerosols, such as saline or detergents, before these procedures will improve drainage from the small bronchi.



The next major step in rehabilitation is the retraining of the respiratory muscles.



Training The Respiratory Muscles . . .

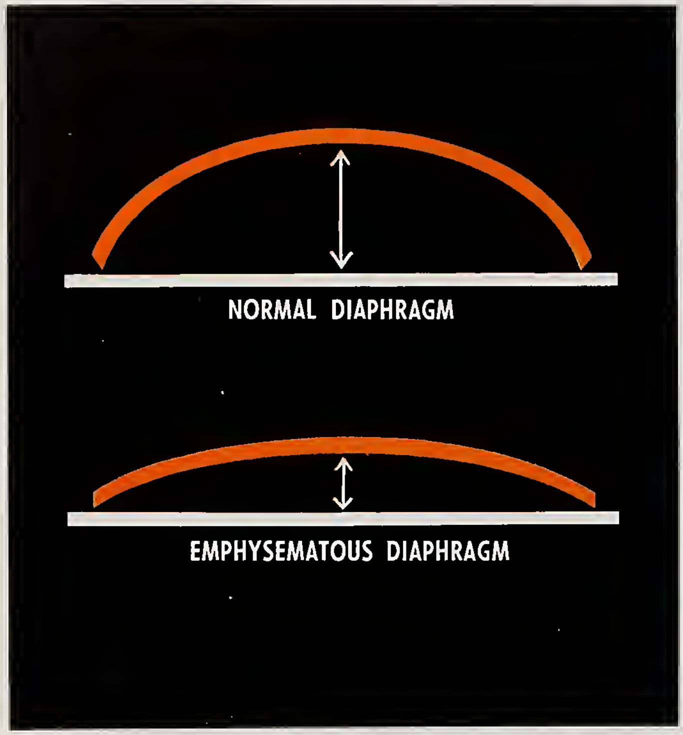
A brief review of the mechanical performance of the rib cage and the diaphragm will be helpful. In the normal situation, the major purpose of the respiratory muscles is to enlarge the thorax during *inspiration*.

The synergistic action created by the descending diaphragm's contraction and the contraction of the rib cage muscles produces the enlargement of the thorax. Expiration, however, is accomplished by the elastic recoil of the lungs, *not* by the respiratory muscles.

Ordinarily, the lung's elasticity, or tendency to recoil, is sufficient to produce a negative pressure in the pleural cavity of about 4 centimeters of water, which increases to 8 centimeters during normal inspiration. This pressure change is responsible for the expansion of the lung.

When exertion requires greater ventilation, the muscles of expiration come into play. These muscles are the internal intercostals acting on the rib cage and the muscles of the anterior abdominal wall which by their contraction force the abdominal viscera to displace the diaphragm upward.

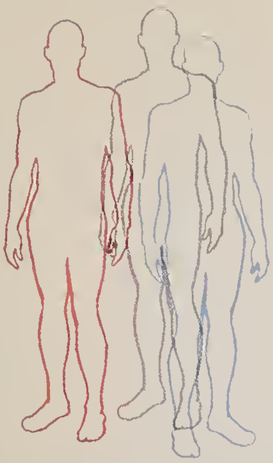
However, the emphysematous lung loses its elasticity and consequently overinflates, causing a consequent over-expansion of the rib cage and a depression of the diaphragm. The problem is now two-fold. The respiratory muscles must do more work to move the diseased lung, and they are operating at a mechanical disadvantage to produce ventilation.

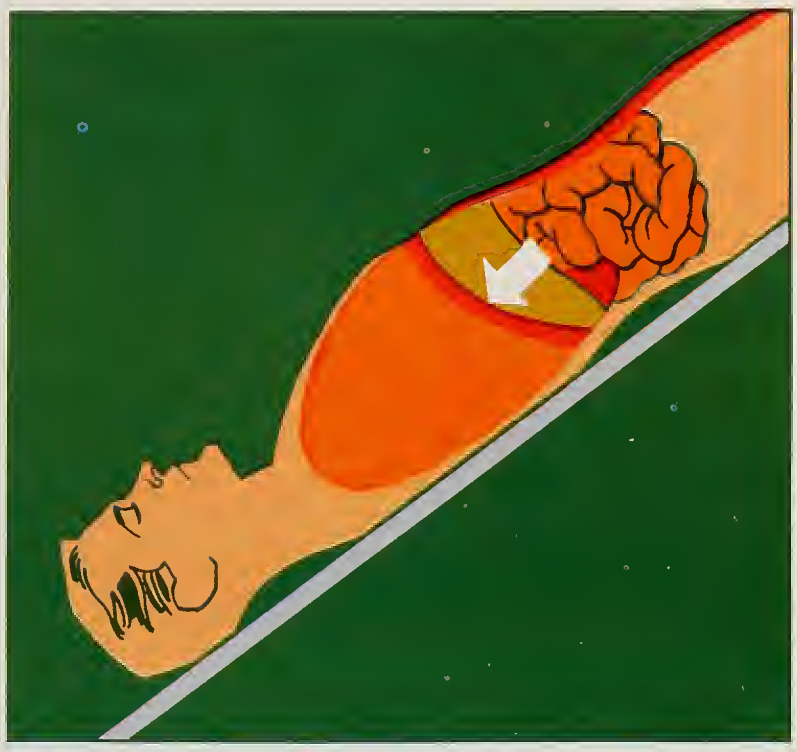


The depressed diaphragm in its shortened position is subject to Starling's law which observes that a shortened muscle has far less contractility for a given stimulus. However, the depressed diaphragm in emphysema is already very near its maximum level of descent. The patient attempts to compensate by using the muscles of the rib cage instead.

Yet the greater the expansion of the rib cage, the more muscular work is required. The patient then must superimpose expansion on an already over-expanded rib cage during inspiration. The energy cost of breathing thus becomes considerably higher.

The amount of work and energy the emphysema patient must expend for ordinary breathing is indicated by the accessory muscles called into play to move the rib cage. These are the sternomastoid, the scalenus group, the trapezius, the latissimus, and other muscles of the trunk. Normally, these muscles are not called upon except for the most strenuous exertions.

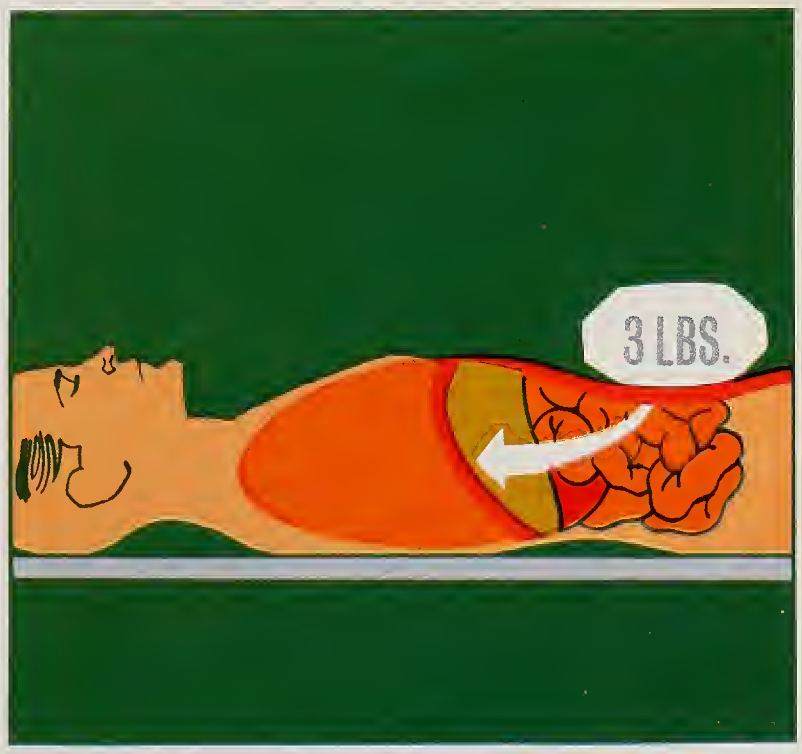


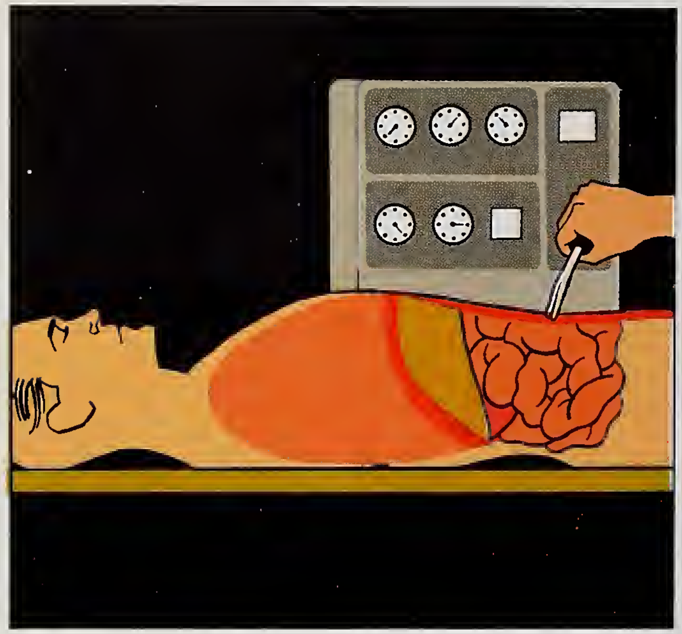


A major purpose of rehabilitation is to approximate the normal pattern of breathing by restoring the mechanical advantages of the normal diaphragm. In short, the principle is to shift the position of the diaphragm upward by mechanical means. There are several ways of accomplishing this.

During the training period the head-down position is often employed to utilize the weight of the abdominal viscera to force the diaphragm upwards.

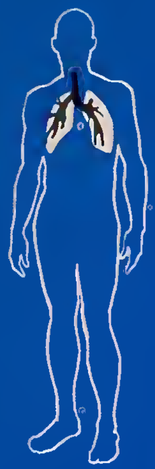
Another procedure is the placement of a series of graduated weights on the anterior abdominal wall.





A more recent method of improving the mechanical advantages of the diaphragm employs the active participation of the muscles of the anterior abdominal wall. The contractility and tone of these muscles can be increased by interrupted periods of galvanic stimulations, the stimuli being imposed during expiration for periods of up to 5 minutes.

After the rehabilitative period and for daily use, an abdominal belt is frequently used for keeping the viscera pressed up against the diaphragm and therefore maintaining its elevated position.



Once the attempts to correct the mechanical disadvantages are underway, the second aim of the breathing exercises, to strengthen the diaphragm to perform the increased work of breathing, can be undertaken.

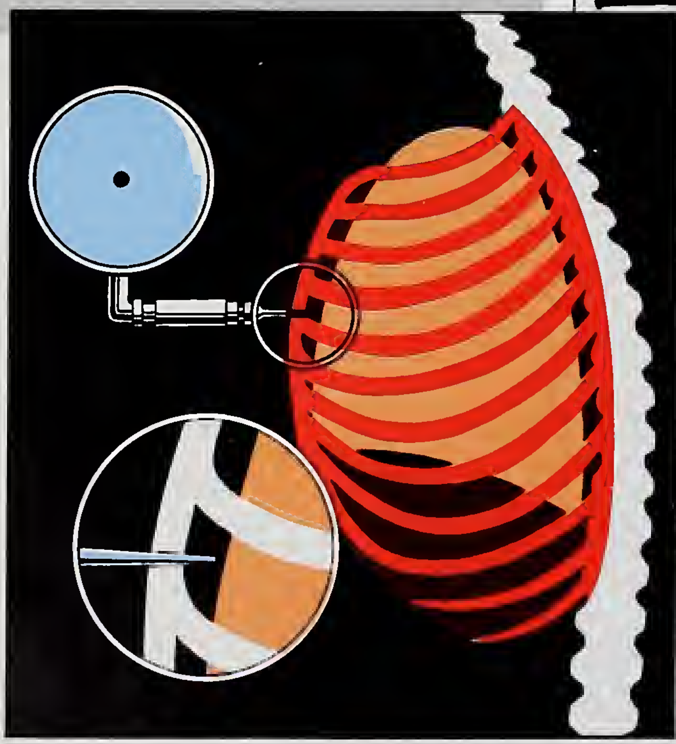
The system for strengthening the diaphragm is derived from our knowledge of other skeletal muscles. When a muscle is made to work against a load such as weights, the bulk and strength of the muscle increases, illustrating the principle of isotonic contraction against graded loads.

In a normal subject, the descent of the diaphragm during inspiration displaces the abdominal viscera, causing the abdomen to bulge. Even under normal conditions the abdominal viscera constitute a work load which must be moved by the diaphragm. However, weight on the abdominal wall becomes an additional load for the diaphragm to move as it descends during inspiration. This additional work load produces an increase in the bulk and strength of the diaphragm in much the same way the barbell does with the biceps. During the training period, graded weights are applied, beginning with 1 pound in the first week, 2 pounds for the second week, 4 pounds for the third week until the maximum of 10 pounds is applied. After the training period, exercises continue with this maximum weight. The goal of muscle training is to establish an advantageous pattern of breathing in which the use of the diaphragm predominates over that of the rib cage. With this in mind, the patient learns to continually observe himself to control the relative movements of his rib cage and abdomen. Movements of the rib cage are discouraged not only in supine, sitting and standing positions but during walking as well.

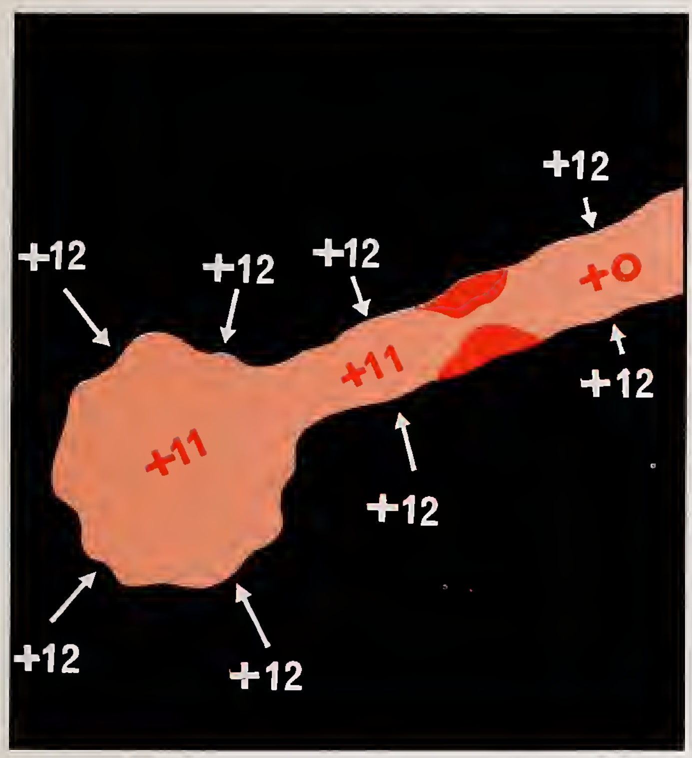
The breathing exercises discussed thus far have been directed to training the diaphragm —a muscle of inspiration; to train the muscles of expiration, other methods are used.

One of the procedures of strengthening those muscles involves expiring against graded resistances.

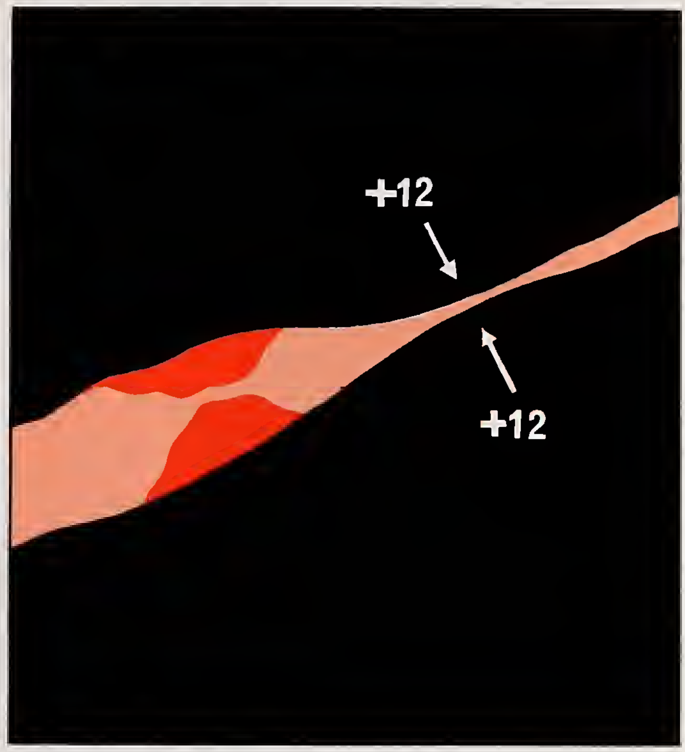
The air expired from the lips exerts pressure on the water pushing it up through the glass tube into the second jar. This exercise, practiced in both a sitting and standing position, lasts 5 minutes at the beginning of the training period and gradually increases to a half-hour.



Expiring against graded resistants is also helpful in training the patient to breathe with pursed lips. The pursed lip maneuver is utilized to prevent the collapse of the airways during expiration in the patient with bronchitis or emphysema. Typically his breathing involves a wide pressure swing in the pleural cavity, going from —14 during inspiration to a +12 on expiration.



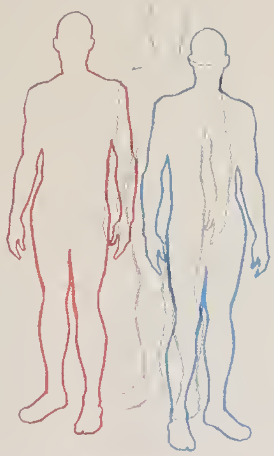
The effect of these high position pressures during expiration is illustrated by a representation of an air space with its terminal bronchus. Here, high positive pressures are exerted not only in the alveolar spaces but also on the outer wall of the bronchus. The presence of a bronchial obstruction prevents rapid emptying of the alveolar space which develops a positive pressure within itself, thereby resisting collapse.



On the other hand, the unobstructed bronchus central to the obstruction bears the brunt of the high positive pressure within the lung and quickly collapses during unusual effort at expiration.

The tendency to collapse, however, may be minimized by imposing a positive pressure within the lumen of the airway to counteract the positive extra luminal pressure. A method of imposing positive pressure within the bronchi to prevent their collapse involves expiring against a resistance at the mouth.

This method can most readily be taught through the use of pursed lip breathing. Pursing the lips has two advantages. Aside from increasing the pressure within the bronchus, it also prolongs the expiratory phase of breathing and converts the inefficient rapid panting into a slower respiratory rate which facilitates emptying the lung. Once the pattern of breathing has been established by this measure, the force of expiration can be improved by the use of a candle and increasing the distance between the lips and the candle.



Other Methods

Still another method of establishing a slower respiratory rate with more time for expiration is undergoing clinical trials. Here, the patient trains himself to breathe correctly through auditory stimuli which are electronic reproductions of breath sounds which can be arranged in any time combination of inspiration and expiration.

Supplemental Oxygen

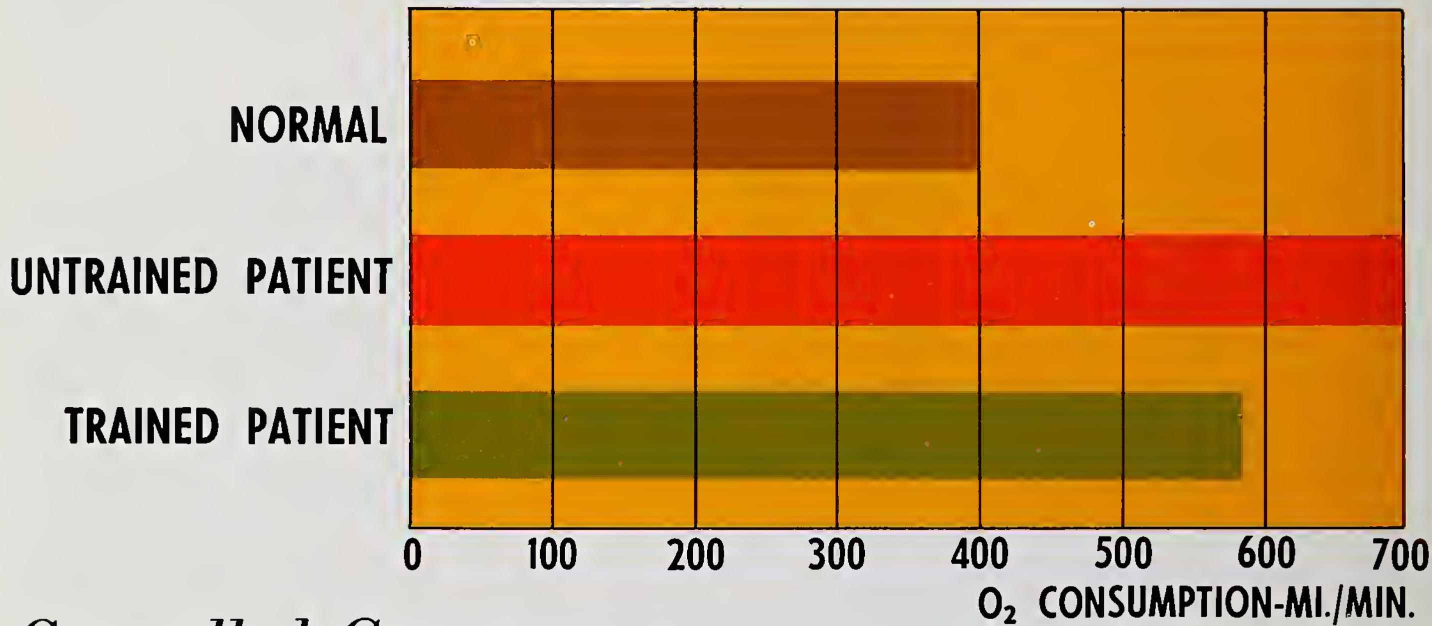
In patients with respiratory insufficiency, the abnormally low arterial oxygen saturation may prevent sufficient oxygen from reaching the respiratory muscles in order to nourish them during exercise. Breathing of supplemental oxygen in normal individuals tends to increase the strength and duration with which a muscle may be exercised.

This principle is applicable as well to patients with hypoxia. The breathing of supplemental oxygen can be expected to provide adequate oxygenation to the muscles especially during the stress of retraining exercises.

Summary

The process of rehabilitation starts immediately with postural drainage and breathing exercises. These are followed by the pursed lip breathing to train the muscles of expiration and the blowing of air against the graded pressure of the water bottles. Finally, there is the use of supplemental oxygen, during the retraining exercises as required.

Stair Climbing



Controlled Group

	REHABILITATION Experimental Group, 128 Patients	NO REHABILITATION Control Group, 50 Patients
MORTALITY	8%	32%
REHOSPITALIZED	23%	40%
CAPABLE OF SELF CARE	16%	2%
RETURNED TO WORK	12%	0
AWAITING JOB PLACEMENT	36%	0
LOST TO FOLLOW-UP	6%	22%

When these rehabilitative measures have been applied, one indication of their efficacy is afforded by measurements of the energy cost of exercise. In this type of study the energy cost is equivalent to the oxygen consumption. The normal individual at rest consumes about 200 milliliters of oxygen per minute. When he climbs the stairs, his oxygen consumption frequently doubles.

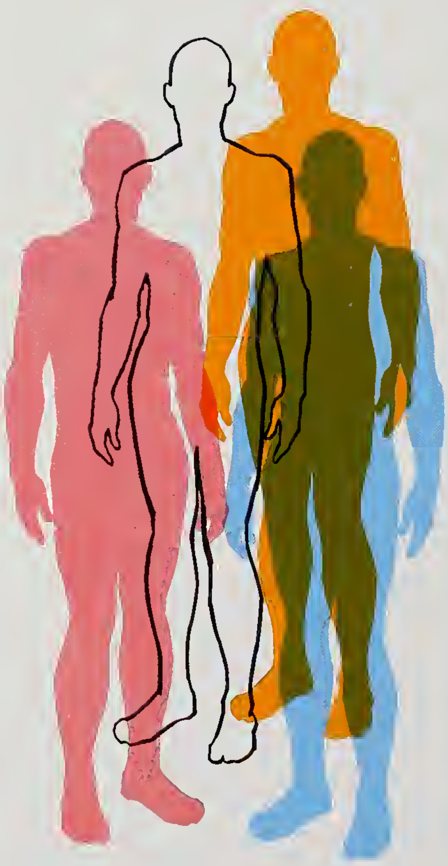
The untrained patient with emphysema or bronchitis consumes approximately the same amount of oxygen as the normal individual when at rest. However, he requires *far more oxygen* for the same stair climbing.

When the patient has undergone a regimen of rehabilitation, he needs far less oxygen for stair climbing. One explanation for this reduction may be that the energy cost of breathing has been decreased by these rehabilitative measures.

When these measures were applied to an experimental group of patients with chronic bronchitis or emphysema, a considerable difference in the end results was evidenced. A group of 128 experimental patients was compared with a controlled group of 50 who had the same severity of lung disease. The mortality rate of the experimental group was 8% whereas in the controlled group it was 32%, four times as much. Rehospitalization in the specially treated group was about half that of the controlled group.

After rehabilitation, 16% were able to achieve self-care. Twelve of the patients returned to work and about 36% were awaiting job placement.

These results clearly illustrate what can be accomplished with a systematic application of physical medicine techniques. Physical rehabilitation, however, must be complemented with a program directed to rehabilitate the patient psychologically, socially and vocationally.



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