How to Connect Pulmonary Rehabilitation to the Home

JMAJ 54(2): 92–98, 2011

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Abstract

The objectives of pulmonary rehabilitation are to alleviate respiratory symptoms, enable maximum use of the remaining respiratory functions and physical functions, enhance the quality of life (QOL), and return the patient to the family and society. Focusing on the patient, pulmonary rehabilitation is carried out by a multidisciplinary team of medical specialists, including physicians, nurses, physical therapists, occupational therapists, case workers, pharmacists, and dieticians. The goals of pulmonary rehabilitation must take into account the patient's home life, in light of the desires and needs of the patient and family. In addition, the targets should be easily accomplished and shared with the patient, with specific goals tailored to each individual patient. Pulmonary rehabilitation consists of exercise therapy, physical conditioning (breathing practice, respiratory muscle training, and drainage therapy), and patient education. When the patient is able to self-manage the specific pulmonary rehabilitation methods in daily life and utilize the acquired knowledge and techniques at home, only then the ultimate goal of pulmonary rehabilitation is satisfied.

Key words Chronic obstructive pulmonary disease (COPD), Pulmonary rehabilitation, Exercise therapy

Introduction—Significance of pulmonary rehabilitation for COPD

Chronic obstructive pulmonary disease (COPD) is an inflammatory disease of the lungs that occurs as a result of long-term exposure to harmful substances, primarily cigars and tobacco.[1] Its characteristic is the limitations of airflow that cannot be restored to normal conditions as indicated by a pulmonary function test. In recent years, it has been conclusively determined that COPD disables not only the lungs, but a wide range of other organs as well. The objectives of pulmonary rehabilitation is to alleviate respiratory symptoms, enable maximum use of the remaining respiratory functions and physical functions, enhance the quality of life (QOL), and return the patient to his family and society.[2]

Focusing on the patient, pulmonary rehabilitation is carried out by a team of multidisciplinary medical/healthcare specialists who work in cooperation. This team consists of physicians, nurses, physical therapists, occupational therapists, case workers, pharmacists, and dieticians, and each has its own roles. When setting a certain goal in a pulmonary rehabilitation program, the targets must take into account the patient's home life, in light of the desires and needs of the patient and family. Also, there should be targets that can be easily accomplished and shared with the patient. Moreover, the specifics of a rehabilitation program should be tailored to each individual patient. There are several goals in pulmonary rehabilitation as shown in **Table 1**, but the ultimate goal is to enable the patient him/herself to utilize the acquired knowledge and techniques in daily life as a mean of self-management.

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This article is a revised English version of a paper originally published in the Journal of the Japan Medical Association (Vol.138, No.12, 2010, pages 2511–2516).

Table 1 Goals of pulmonary rehabilitation for the patients

• Patient can breathe more easily	• Patient can enjoy hobbies and trips
• Patient becomes more active	• Anxiety and depression are alleviated
• Quality of life (QOL) improves	• Prevent acute exacerbation and hospitalization
• Exercise endurance improves	• Patient gains independence and confidence
• Activities of daily living (ADL) improves	• Patient returns to work

Table 2 Criteria for selecting patients for pulmonary rehabilitation

(1) Chronic lung disease with subjective symptoms
(2) Patient condition is stable as a result of standard treatment
(3) Patient have functional limitations due to disease
(4) No factors or unstable complication exist that prevents rehabilitation
(5) The patient is motivated to proactively participate in his/her own treatment and has a strong sense of self-responsibility
(6) No absolute criteria should exist based on age limitations or pulmonary function data

[Extracted and modified from The Japan Society for Respiratory Care Medicine and The Japanese Respiratory Society.[4]]

Applicability, Contraindications and Patient Selection in Pulmonary Rehabilitation[2,3]

A rehabilitation program should be properly prescribed to each patient on an individual basis based on the severity, level of understanding, and motivation of the patient (**Table 2**).[4]

Components of Pulmonary Rehabilitation[2]

Pulmonary rehabilitation consists primarily of 3 components, namely: (1) exercise therapy, (2) physical conditioning (breathing practice, training of the respiratory muscles, and drainage therapy), and (3) education and instruction. Of these, exercise therapy is the most important part of pulmonary rehabilitation, and physical conditioning is used to facilitate exercise therapy. The specific aspects of pulmonary rehabilitation are summarized below.

- Evaluation: assessed by a multidisciplinary medical team
- Patient education: include better understanding of the disease and disorder (pathophysiology), drug therapy and patient compliance instruction on the dosage and administration (particularly for oxygen inhalation therapy), nutritional guidance, guidance on activity of daily living (ADL), oxygen therapy, smoking cessation, self-assessment, and symptom management
- Exercise therapy: muscle training for upper and lower limbs, and exercise prescription
- Physical conditioning: relaxation, breathing practice, training of the respiratory muscles, practice of thoracic range of motion, and airway clearance therapy (drainage therapy)
- Psychosocial support: include the approaches to depression, anxiety, and panic, sex counseling, lifestyle improvements, and emotional encouragement and support
- Follow-up

Evaluation in Pulmonary Rehabilitation[2]

When selecting appropriate evaluation items, a physician must incorporate the patient's condition at the time. The objectives of evaluation include identifying the factors that would impede improvements, finding information that would aid in setting goals and planning a program, and assessing the effect of the rehabilitation. The evaluation items are shown in **Table 3**.[3]

Table 3 Evaluation criteria in pulmonary rehabilitation

Essential evaluation items
- Interview
- Pulmonary function test
- Chest X-ray
- Electrocardiogram
- Assessment of dyspnea
  Direct assessment: visual analog scale (VAS), Borg scale
  Indirect assessment: MRC, chronic respiratory disease questionnaire (CRQ), baseline dyspnea index (BDI), and transitional dyspnea index (TDI)
- Percutaneous oxygen saturation (SpO_2)
- Field exercise test with pulse oximetry
- Grip strength

Desirable evaluation items
- Assessment of exercise ability: 6-min walking test, shuttle walking test (ISWT, ESWT)
- Assessment of nutritional condition: body composition, prognostic nutritional index (PNI), creatinine height index (CHI), calorie intake
- Assessment of activities of daily living (ADL): through interviews and observations
  From questionnaires: Methods proposed by Spector and others, Nagasaki University Respiratory Activity Living Score (NRADL), pulmonary functional status scale (PFSS), pulmonary functional status and dyspnea questionnaire (PFSDQ)

Evaluation items (when possible)
- Exercise tolerance test
- Assessment of limb muscle strength: strength of the quadriceps femoris muscle
- Respiratory muscle strength
- Health-related quality of living (HRQOL)
  Comprehensive scales: sickness impact profile (SIP), Nottingham health profile (NHP), MOS Short Form 36 (SF-36)
  Disease-specific scales: chronic respiratory disease questionnaire (CRQ), St. George's respiratory Questionnaire (SGRQ)
- Arterial blood gas analysis
- Echocardiography

Procedures for Pulmonary Rehabilitation[2,3]

Pulmonary rehabilitation is implemented through the following processes.
- Patient selection
- Identification of the patient' needs
- Setting goals
- Preparing a rehabilitation treatment program tailored to individual patients
- Evaluation of the extent of goals achieved and the need for additional aids
- Review of a rehabilitation treatment program
- Formulation of home rehabilitation program for self-management
- Assessment of the need for follow-up, and reevaluation of a home rehabilitation program

The Role of Respiratory Physiotherapy in Pulmonary Rehabilitation[2]

Respiratory physiotherapy, namely exercise therapy and physical conditioning, is intended to improve the patient life by alleviating subjective symptoms such as dyspnea, giving greater independence in ADL, and expanding his/her range of activity. These improvements form the core of pulmonary rehabilitation. The main roles of respiratory physiotherapy are as follows.
- Enhance physical capabilities by developing the adaptability of limb muscles and the cardiovascular system
- Prevent physical deconditioning and improve physical conditions
- Improve gas exchange through effective use of

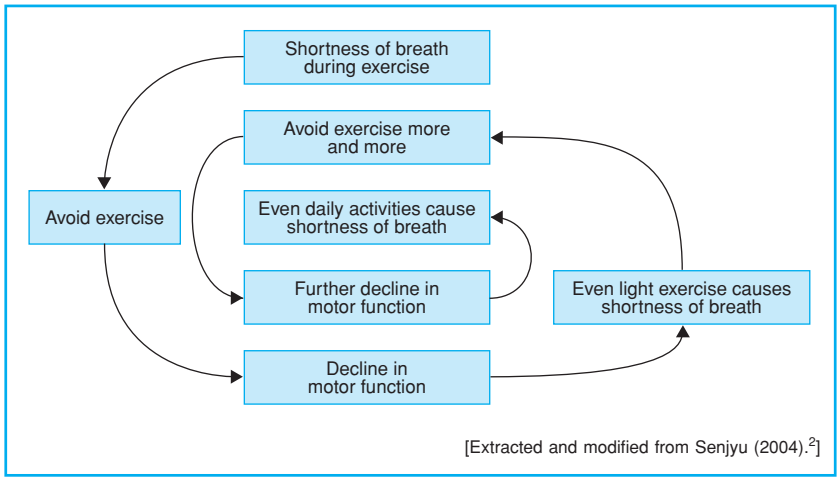

Fig. 1 Negative cycle of shortness of breath

the remaining respiratory function
- Improve ventilatory function by using the respiratory muscles and chest

Exercise Therapy and Physical Conditioning

Exercise therapy[2,3]

Many COPD patients experience dyspnea due to severe ventilation limitations brought on by physical exertion. As a result, their exercise is discontinued at an early stage, and physical activities in daily life become limited. Airflow limitations resulting from airway obstructions determine ventilation capacity. As the exercise stress increases, the necessary ventilator volume increases, and dyspnea worsens.

With COPD, sensations related to ventilation—particularly the sense of effort involved in breathing—account for most of the perception of dyspnea. When exertion causes hyperventilation, the patient experiences dynamic hyperinflation, in which the end-expiratory lung capacity dynamically increases. This restricts the tidal volume and the mobility of the diaphragm and increases the elastic work of the chest wall, which lead to positive end-expiratory pressure (auto PEEP) in the pulmonary alveoli. This condition results in delays in exhalation phase, dramatically increasing the perception of dyspnea.

Since COPD patients experience dyspnea during exertion, they decrease their physical activity. Reducing physical activity easily decreases the functioning of the cardiovascular system and peripheral muscles (i.e., physical deconditioning, as in reduced oxygen supply to the working muscles, decreased capillary density within the muscles, and lower oxidative enzyme activity). If this state remains unchanged, it results in further lack of exercise and worsens the physical deconditioning. Deconditioning increases the demand for ventilation during exertion, and this itself exacerbates the shortness of breath. When this shortness of breath is exacerbated, exertion is further constrained, and deconditioning worsens even more. In this way, a negative cycle is formed between dyspnea during exertion and physical deconditioning, and dyspnea is exacerbated without any correlation to pulmonary function (**Fig. 1**).[3]

Exercise therapy breaks the negative cycle of physical deconditioning. By reducing lactic acid production in the muscles during exertion and therefore decreasing ventilation demand, it can alleviate dyspnea and raise exercise tolerance. Exercise therapy can reliably improve exercise tolerance during the chronic stable stage. This improvement appears as an additive effect to drug therapy and oxygen therapy, and it is not essentially related to changes in pulmonary functions and blood gas, unlike drug and oxygen therapies. By enhancing the patient's ability to

adapt his/her physical motor functions, exercise therapy can be expected to alleviate the shortness of breath and improve exercise capacity and ADL.

The practical aspects of exercise therapy are as follows.

- Exercise intensity: Either 40 to 80% of maximum exercise capacity with high-intensity load equivalent to maximal oxygen uptake (VO_2max), or 60 to 80% of maximum exercise capacity with low-intensity load (40 to 60% of VO_2max). The exercise intensity is gradually raised from a low-intensity to high-intensity load. A training program should use modifications as necessary, such as the interval method.
- Types of exercise: Options include walking, climbing stairs, treadmill, ergometer and other exercises. Full-body exercise is recommended.
- Exercise time and frequency: Exercise should be 15 to 30 minutes in duration. It is important to maintain a certain level of intensity. Frequency should be 3 to 5 times a week.
- For mild to moderate cases that corresponds to Grades 1 or 2 in the dyspnea scale of British Medical Research Council (MRC): 15 to 30 minutes, at 70% load of maximum exercise capacity
- For severe cases (Grade 3 and above in the MRC dyspnea scale): at 40 to 60% load or high intensity load, in 2-min intervals, 3 to 5 sets
- Thorough risk management: Avoid SpO_2 below 85% and a heart rate over 120 bpm. Subjective symptoms such as dyspnea and fatigue are evaluated using the Borg scale. The divergence between the degree of hypoxemia and dyspnea should be monitored.
- It takes approximately 8 weeks for the maximum effect of exercise therapy to be realized. But exercise therapy should be continued for as long as possible since the effect quickly disappear (in about 8 weeks) when discontinued.
- A home rehabilitation program is needed on continuous basis, which should cover exercise methods like walking and muscle training that accommodate the patient's lifestyle. Important aspects to consider include how to motivate the patient to continue his/her exercise program and how to raise his/her motivation.
- Instructions in other physical therapy methods should also be provided, such as physical training for limb and trunk muscles (use of weights, standing up from chair, step practice, etc.), matching breathing to movements as a mean of ADL practice, experiencing shortness of breath intentionally, and movement skills.

Relaxation and respiratory (control) practice[2]

COPD patients tend to take fast, shallow breaths using their neck and shoulder muscles. This way of breathing is not efficient as it increases the amount of oxygen that must be consumed in respiratory movements. Accordingly, patients must undergo training in respiratory control so that they can consciously adjust their breathing and manage the panic they feel when experiencing shortness of breath. Also, a gradual, relaxed breathing pattern improves ventilation imbalances, enhances the efficiency of gas exchange, and promotes recovery from the hypoxemia resulting from exertion. For example, pursed-lip breathing prevents the collapse of the distal airway and eases expiration during labored breathing.

COPD patients are generally instructed in pursed-lip respiration and diaphragmatic respiration. However, these respiratory control methods should not be forced on the patient, unless they provide benefits of improving subjective symptoms and enabling the quick recovery from shortness of breath. The main methods of respiratory control are relaxation, pursed-lip breathing, and control of respiratory patterns. But many patients cannot breathe from the abdomen, and they should not be forced. Relaxing before respiratory control training eases the patient both physically and mentally and alleviates respiratory effort. Furthermore, pre-training relaxation also improves the patient's motivation to pursue the treatment.

Training methods for relaxation and respiratory control practice are as follows.

- For relaxation (to encourage mental and physical relaxation): comfortable position, stretching of the respiratory muscles, massage, manual ventilation assistance technique, progressive muscle relaxation method, biofeedback, music therapy, image training, etc.
- Respiratory control practice (to control breathing patterns): pursed-lip breathing, abdominal breathing, and breathing control during movements

Respiratory muscle training[2]

The respiratory muscles, particularly the diaphragm, play an important role as a pump in

the ventilatory movement. COPD patients tend to experience loss of muscle efficiency and muscular strength in their diaphragms due to various factors, such as an increase in the work required to breath, and thus fatigue easily. As a result, they can easily succumb to respiratory failure.

The respiratory muscle training is one way of addressing the lower muscular strength of the diaphragm. As with limb muscles, the diaphragm can increase in muscle strength and endurance through training. Here, it should be noted that muscle fatigue and reduced muscle strength are fundamentally different conditions in the respiratory muscles. The respiratory muscle training only addresses the reduced strength of the respiratory muscles, and is contraindicated in the case of respiratory muscle fatigue. Respiratory muscle fatigue should, in principle, be addressed by giving the lungs a rest by using artificial ventilation.

Method of respiratory muscles training that reinforce the strength and endurance of the respiratory muscles are described below.

- Hyperventilation method: use incentive spirometry (flow-oriented type: Inspirex, Triflo) or other means
- Resistive breathing methods: use an abdominal pad, PFLEX device, threshold loading device, or other means. The target load should be 0.5 to 3 kg for the abdominal pad method, 30% of maximum intake pressure for the threshold method.

Exercise to increase thoracic range of motion[2]

Breathing shallow and fast over a long period due to severe dyspnea restricts the mobility of the synovial joints and the extensibility of the muscles in the thorax, which reduces the expandability of the thorax. Lower thoracic mobility aggravates the perception of dyspnea even further and also increases the work required of the respiratory muscles. By increasing the flexibility and mobility of the thorax, the thoracic expandability is improved and the load on the respiratory muscles is decreased, therefore making it easier for the patient to breathe.

Methods to improve thoracic range of motion that would increase the flexibility of thoracic movements are described below.

- Manual thoracic extension methods: include rib rotation, respiratory muscle stretch, intercostal muscle extension method
- Other methods include breathing exercises, stretching exercises for respiratory muscles, etc.

Airway clearance method (drainage therapy)[2]

A large volume of discharge accumulates in the patient who has heavy airway secretions. The accumulated secretions increase viscosity and make it even harder for the patient to drain or expectorate, requiring a great deal of effort to cough up the sputum. The retention of airway secretions also tends to increase airway obstructions, reduces gas exchange, and cause airway infections.

Drainage therapy is used to facilitate drainage of accumulated secretions in the airway and to prevent their negative effects. The objective of drainage therapy is to improve the patient's QOL by having the self-control to expectorate sputum and easing the pain due to coughing and sputum. Accordingly, the ultimate objective is for the patient to master the drainage methods so that he/she can self-administer them at home. Drainage therapy has limited application, and therefore should only be used only with patients who can handle over 30 ml of sputum expectoration per day.

The methods of drainage therapy are as follows.

- Postural drainage method: The patient is positioned so that the segmental bronchus in the pulmonary segment where secretions accumulate is vertical. The drainage of the accumulated secretions (sputum) is encouraged by taking advantage of the force of gravity. Typically, the drainage techniques are used simultaneously to encourage the movement of the secretions within the airway.
- Manual drainage techniques: include chest percussion, shaking and jiggling, and squeezing
- Manual ventilation assistance techniques
- Other techniques, such as coughing and huffing
- Combined with inhalation therapy: use an ultrasonic nebulizer, jet nebulizer, intermittent positive-pressure breathing (IPPB), or intrapulmonary percussive ventilator
- Self-administered drainage methods using a drainage tool: use a valve or Acapella
- Self-administered drainage therapy without drainage tools, such as active cycle of breathing technique (ACBT)

Conclusion

Pulmonary rehabilitation focuses on exercise therapy, with the aim of improving subjective symptoms and physical functions such as dyspnea. The effect of exercise therapy can augment the effect of drug therapy. However, if it is discontinued, the improved motor function acquired from pulmonary rehabilitation will regress within a short time to the level when the exercise program was started. In order to maintain the functions that are built up in the course of pulmonary rehabilitation, it is important for the patient to incorporate the knowledge and techniques of pulmonary rehabilitation within everyday life. Physicians and healthcare professionals must provide patient education and support on continuous basis to further expand the patient's range of activities.

References

1. Committee for the Third Edition of the COPD Guidelines of The Japanese Respiratory Society. Guidelines for the Diagnosis and Treatment of COPD (Chronic Obstructive Pulmonary Disease). 3rd ed. Tokyo: Medical Review Co., Ltd.; 2009.
2. Senjyu H. Introduction to Pulmonary Rehabilitation. 4th ed. Hyogo: Shinryo Bunko; 2004. (in Japanese)
3. The Japan Society for Respiratory Care Medicine (currently The Japan Society for Respiratory Care and Rehabilitation Medicine), The Japanese Respiratory Society, The Japanese Physical Therapy Association, ed. Pulmonary Rehabilitation Manual: Exercise Therapy. Tokyo: Shorinsha; 2003. (in Japanese)
4. The Japan Society for Respiratory Care Medicine (currently The Japan Society for Respiratory Care and Rehabilitation Medicine), The Japanese Respiratory Society. The statements regarding pulmonary rehabilitation. The Journal of The Japan Respiratory Society. 2002;40(6):536–544.