Pulmonary Rehabilitation in Chronic Obstructive Pulmonary Disease

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is defined as a common, preventable, and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases. Pulmonary rehabilitation is an essential component in management of COPD, which improves dyspnea, fatigue, and betters the quality of life.

Materials and methods: A literature review was performed using different database with search words COPD, pulmonary rehabilitation and it combination.

Results and conclusion: Pulmonary rehabilitation is not only beneficial in severe disease COPD rather it should be administered to mild cases of COPD also. Patients should be referred to pulmonary rehabilitation early during the course of the disease in order to minimize the consequences of COPD. Rehabilitation start with thorough assessment of the patient followed by individualized therapy, which includes not only exercise but also education, nutritional advice, and psychological therapy.

Keywords: Breathing exercise, Chronic obstructive pulmonary disease, Pulmonary rehabilitation.

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INTRODUCTION

Pulmonary rehabilitation is a vital component in the management of chronic obstructive pulmonary disease (COPD) patients. The American Thoracic Society/European Respiratory Society have recently defined pulmonary rehabilitation as “a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies that include, but are not limited to, exercise training, education, and behavior change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviors.” The goals of pulmonary rehabilitation are to minimize symptom burden, maximize exercise performance, promote autonomy, increase participation in everyday activities, improve health-related quality of life, and effectuate long-term health-enhancing behavior changes.

There are several studies performed on various aspects of the role of pulmonary rehabilitation in COPD. This review can be summarized in the following headings:

• Rehabilitation setting
• Indications and contraindications of pulmonary rehabilitation (Table 1)
• Pulmonary rehabilitation program

REHABILITATION SETTING

Before describing different components of the pulmonary rehabilitation program, let us discuss about the rehabilitation setting, when to initiate rehabilitation, and what should be the duration of rehabilitation. Pulmonary rehabilitation can be provided through an outpatient program and an inpatient program. Outpatient settings include the outpatient department of a hospital, community facilities, or physiotherapy clinics. Outpatient programs are supervised by physiotherapists. Inpatient programs are offered in hospitals for individuals in a stable pulmonary state or after an exacerbation. It is beneficial for patients with disability or severe functional limitation who cannot regularly attend outpatient programs, and for patients who require daily ongoing medical and/or nursing care. Factors that influence the selection of a rehabilitation setting include characteristics of a particular healthcare setting or system such as availability of long-term programs, availability of inpatient or outpatient programs, transportation to and from the pulmonary rehabilitation program, and payment considerations. Selection of either inpatient or outpatient programs is based on patient-specific factors such as disease severity, stable or unstable pulmonary state, degree of disability, and extent of comorbidities. These factors influence the extent of supervision required during physical exercise, need for more individualized patient education, psychosocial, occupational, and/or nutritional intervention, and the need for various modalities of physical exercise.
Indications and Contraindications of Pulmonary Rehabilitation

Indications and contraindications of pulmonary rehabilitation are enlisted in Table 1.

Table 1: Indications and contraindications of pulmonary rehabilitation

Indications:
- Persistent respiratory symptoms, especially dyspnea
- Limitation of functional status despite optimal medication
- Impaired health-related quality of life
- Decreased occupational performance
- Difficulty performing activities of daily living
- Difficulty with the medical regimen
- Psychosocial problems attendant on the underlying respiratory illness
- Nutritional depletion
- Increased use of medical resources, e.g., frequent exacerbations, hospitalizations, emergency room visits
- Gas exchange abnormalities including hypoxemia

Contraindications:
- Conditions that substantially increase the risk during rehabilitation, e.g., unstable angina
- Conditions that substantially interfere with the rehabilitative process
- Uncontrolled diabetes
- Psychiatric illness, such as dementia
- Severe exercise-induced hypoxemia, not correctable with oxygen supplementation
- Inability to exercise due to orthopedic or other reasons

Patient Selection and Assessment

Traditionally, patients with severe COPD are recruited to pulmonary rehabilitation programs. However, latest evidence suggests that pulmonary rehabilitation significantly improves outcomes even in patients with less severe disease. Reduced physical activity, problems with activities of day-to-day living, dynamic hyperinflation with exercise, weakness in lower limb, osteoporosis, anxiety, and depression may also be noted in patients with mild-to-moderate airflow limitation. Hence, initiation of pulmonary rehabilitation at an early stage of the disease improves exercise tolerance and physical activity, promotes self-efficacy and behavior change, and decreases exacerbations, and thus has the potential to markedly alter the disease course. Pulmonary rehabilitation can also be initiated during hospitalization for an acute exacerbation. Although aerobic exercise training may not be possible due to ventilatory limitation during acute exacerbations, resistance training of the lower extremity muscles during hospitalization for acute exacerbation has been reported to be safe and well-tolerated, leading to improvement in muscle strength and 6-minute walk distance.

Evidence suggests that early initiation of pulmonary rehabilitation, for example, within 3 weeks after hospitalization for an acute exacerbation, is feasible, safe, and effective, and improves exercise tolerance, symptoms, and quality of life. Pulmonary rehabilitation in the post-hospitalization period also reduces healthcare use, readmissions, and mortality. There is no consensus on the optimal duration of pulmonary rehabilitation. However, it is ideally determined by continued progress toward goals and optimization of benefit. It is also influenced by the availability of the program resources. The optimal duration for an individual can be regarded as the longest duration that is practically possible, since programs lasting longer than 12 weeks have been shown to confer greater sustainable benefits than shorter programs. Outpatient programs are usually scheduled twice or thrice in a week, while inpatient programs are planned for 5 days in a week. The session is usually carried out for 1–4 hours. However, the total duration of a rehabilitation program and the number of sessions per week vary across countries.

Exercise Training

Exercise training is the most important component of a pulmonary rehabilitation program. Exercise training is based on three main principles: Intensity means higher intensity produces greater results, specificity means only the muscles that are trained produce the desired effect, and reversibility means stopping regular exercise training decreases the effect.

There are two type of exercise training. It is either endurance or strength based. Continuous or intermittent. The target muscle area, upper limbs, lower limbs, and the inspiratory muscles, must be included in the exercise training programs. The duration of each exercise session can range from 15 to 45 minutes, and may be carried out either daily or once a week. Each session must include warm-up and cool-down periods of 5–10 minutes each. Warm-up periods facilitate gradual increase in heart rate, blood pressure, ventilation, and blood flow to the exercising muscles. The cool-down periods decrease the risk of arrhythmias, orthostatic hypotension, bronchospasm, and syncopal episodes. Supplemental oxygen should be provided for patients who develop exertional hypoxemia. Endurance training involves performing repetitive actions, such as walking, cycling, and swimming, over an extended period of time. Cycling on a stationary cycle ergometer and walking either on the ground or on a treadmill are optimal exercises to improve endurance of the muscles. Walking should be suggested if the primary goal is to increase walking endurance. Biking places a greater specific load on the quadriceps than walking, and thus results in less exercise-induced oxygen desaturation. Endurance exercises can be performed three to five times a week. Despite being the mainstay of exercise training in pulmonary rehabilitation programs, endurance training confers suboptimal increase in muscle mass or strength, when compared with strength training programs.

Strength training involves performing explosive activities, such as sprinting, jumping, and lifting weights, over a short period of time. It is an exercise modality in which local muscle groups are trained by repetitive lifting of relatively heavy loads. Muscle weakness is an important risk factor contributing to falls in elderly...
COPD patients. Hence, optimizing muscle strength is a vital goal of rehabilitation in these patients. Studies have suggested that resistance training may also help to maintain or improve bone mineral density, which has been reported to be abnormally low in nearly 50% of patients with COPD. Such a training modality is crucial to promote healthy aging and is indicated in patients with reduced mass and strength of peripheral muscles. Strength training, when compared with endurance training, has greater potential to enhance muscle mass and strength. It also results in less dyspnea during the exercise period and is therefore easier to tolerate when compared with endurance constant-load training. Examples of strength training exercises include free weights, hand and ankle weights, using one’s body weight, such as squats or stair climbing, elastic resistance, machine weights, sit to stand exercise on a chair, etc. To improve muscle endurance, it is recommended to begin exercises with lower weights and more repetitions. Need to remember higher weights and fewer repetitions promote muscle strength. It is crucial to perform these exercises safely to avoid muscle tears, especially in patients on chronic steroid therapy, since these persons are at risk of muscle or tendon rupture on exposure to high-intensity loads. A combination of strength plus aerobic fitness training helps to gain muscle strength and endurance. The combination approach is safe and is the recommended approach in pulmonary rehabilitation. In COPD patients, activities of daily living, such as dressing, bathing, and performing household tasks, are problematic.

Upper limb training is typically integrated into the pulmonary rehabilitation exercise regimen. The muscles that are typically targeted include biceps, triceps, deltoids, latissimus dorsi, and pectorals, and the exercise to train the upper limb include making circles in air with each arm in which hold one arm away from the body at the shoulder level. Move the arm to make circles in air. Begin with a small circle. Progressively increase the size of the circle for a count of six circles in 10 seconds. Next, decrease the size of the circles over another count of six. Repeat this for 40 seconds. Repeat this exercise with the other arm (Fig. 1A). Wall press ups: Stand against the wall at a distance of one arm length. Place your hands on the wall and bend at the elbow toward the wall, till the nose touches the wall. Push the arms straight again, allowing 8 seconds from start to completion. Repeat this five times to a total of 40 seconds. Do this exercise three times taking short rests in-between (Fig. 1B). Other exercise could be throwing a ball against the wall with arms above horizontal in sitting position, passing a beanbag over the head in sitting position, exercises on overhead pulleys in sitting position, moving a ring across a wire without touching the wire, while holding the arm above horizontal. These exercises are performed for 40 seconds followed by 20 seconds of rest and should be repeated four times in 4 minutes.

Dysfunction of the lower limb muscles is mainly responsible for exercise limitation in patients with COPD. Evidence-based guidelines suggest that lower extremity muscle training provides the best physiological gains. The exercises to strengthen lower limb muscle are sitting to standing exercise on chair in which use an ordinary chair to sit, stand, and sit taking 10 seconds from start to completion. Repeat this continuously for 40 seconds (Fig. 2A). Do this exercise thrice with short rests in-between and then quadriceps exercise in which sit on an ordinary chair and straighten the knee and tense the thigh muscles. Hold in the same position for a count of four, then gradually relax for another 4 seconds. Repeat this five times over 40 seconds. Do the exercise thrice with short periods in-between. Repeat this exercise with the other leg (Fig. 2B). Other different exercises are treadmill walking, cycle ergometry, corridor walking, modified weight lifting, walking on a flat track or at home, and brisk walking for 5–30 minutes.

Role of Yoga
Studies have demonstrated that yogic asanas confer beneficial effects in patients with COPD. The benefits could be in forms of improved functional performance, decreases dyspnea-related distress, and easing of anxiety. Yoga improves blood circulation leading to better tissue perfusion and increased strength of respiratory muscles. The sequence of asanas that have been shown to be beneficial is (Figs 3A and B):

- Tadasana or the mountain pose
- Adhomukha svanasana or the half dog pose
- Adhomukha virasana or the child’s pose
- Trikonasana or the triangle pose
- Bhujangasana or the cobra pose
- Bharadvajasana or the simple twist
- Salamba setu bandhasana or the supported bridge pose

Figs 1A and B: (A) Arm circle exercise; (B) Standing wall push up
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Dandasana
Baddha konasana
Savasana with gradual inclusion of sama vritti and pranayama visama vritti

Inspiratory Muscle Training
In individuals with COPD, the pressure-generating capacity of the inspiratory pump muscles is reduced, primarily due to the deleterious effects of pulmonary hyperinflation, which shortens and flattens the diaphragm. Reduced pressure-generating capacity of the inspiratory muscles leads to exercise intolerance and the perception of dyspnea in COPD patients. There are three types of inspiratory muscle training, namely voluntary isocapnic hyperventilation, inspiratory threshold loading, and inspiratory resistive loading. It has been hypothesized that use of inspiratory muscle training as an adjunct to whole-body exercise training may be beneficial in COPD patients with marked inspiratory muscle weakness. The flattened diaphragm must generate greater tension to develop the transpulmonary pressure required to produce tidal breathing. This follows from Laplace’s law, $P = \frac{2T}{r}$. As the radius of diaphragm curvature ($r$) increases with diaphragm flattening, the tension ($T$) required to develop a transpulmonary pressure ($P$) to generate tidal breathing must increase.

Patient Education
Patient education is an integral component of pulmonary rehabilitation, which confers various benefits like promotes self-efficacy, encourages active participation in health care, is highly effective in improving health status, and reduces healthcare utilization. Patients should be educated about several topics that should include concept of normal lung function, various aspects of the disease and its prognosis, risks and benefits of stopping smoking and various cessation strategies, avoidance of potential risk factors in nonsmokers, how to clear secretions, role of slow deep breathing instead of rapid shallow breathing to minimize diffuse hypoxic injury and exertional shortness of breath, appropriate inhaler technique, benefits of drugs prescribed, including oxygen, significance of good compliance to therapy, importance of exercise, diet, and energy conservation, premonitory signs of an exacerbation, which may help the patient to identify the signs early and avoid severe exacerbations, and end-of-life planning.

Nutritional Support
The inclusion of nutritional support and ketogenic diet into structured rehabilitation programs has been debated. The COPD patients present with several changes, the most prominent being loss of total body fat mass as well as fat-free mass. Simple methods to assess the nutritional status of COPD patients include subjective assessment and assessment of BMI. Individuals with COPD will need caloric supplementation to meet the demands of increased energy. In patients with a BMI of $<21$ kg/m$^2$ or loss of $>10\%$ body weight during the past 6 months, adequate carbohydrates have to be provided with monitoring of resting PaCO$_2$ value. Proteins are also needed to build fat-free mass. A Cochrane meta-analysis, which included 632 participants, reported that providing nutritional support for at least 2 weeks resulted in a difference in the outcome parameters of respiratory muscle strength and quality of life. The
Pulmonary rehabilitation, a vital component in the management of COPD, comprises essential components such as patient selection and assessment, exercise training, education, nutritional support, psychological support, and outcome assessment. Pulmonary rehabilitation can be provided through outpatient, inpatient, home-based, or technology-assisted programs. In resource-poor settings such as India, where it is often difficult to set up community-based programs, domiciliary rehabilitation programs provide positive results. Domiciliary pulmonary rehabilitation improves exercise endurance, dyspnea, and quality of life in patients with stable and severe COPD, and thus serves as a substitute to conventional rehabilitation programs in resource-poor situations. Patients should be referred to pulmonary rehabilitation early during the course of the disease in order to minimize the consequences of COPD. The total duration of a rehabilitation program and the number of sessions per week vary across countries.

References