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Article *in* Physiotherapy - The Journal of Indian Association of Physiotherapists · October 2019

DOI: 10.4103/PJIAP.PJIAP_46_18

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Guidelines for the physiotherapy management of chronic obstructive pulmonary disease

Subin Solomen

Abstract:

The purpose of the article is to provide guidelines for the physiotherapy management of patients with chronic obstructive pulmonary disease (COPD). The various publications on the same topic were brought together with input from several textbooks in the field of cardiorespiratory physiotherapy and translated into clinical practice. This article briefs with definition, risk factors, prevalence, clinical features, investigations, differential diagnosis, and management of COPD patient. Then, information on physiotherapy management during acute exacerbation phase and during stable phase is detailed. The article provides specific details on the rationale of why and especially how to implement exercise training in patients with COPD.

Keywords:

Chronic obstructive pulmonary disease, exercise training, guidelines, physiotherapy, pulmonary rehabilitation

Introduction

Chronic obstructive pulmonary disease (COPD) is a common, preventable lung disorder characterized by progressive, poorly reversible airflow limitation often with systemic manifestations, in response to tobacco smoke and/or other harmful inhalational exposures. The established risk factors for COPD are tobacco smoking, exposure to biomass fuel smoke, occupational exposure, and alpha-1 antitrypsin deficiency.[1] The prevalence of COPD in India according to previous studies was 4.46% in males and 2.86% in females.[2,3] Chronic obstructive pulmonary disease is a major cause of morbidity and mortality in India. Drug treatment alone does not optimize therapy. Pulmonary rehabilitation has been found to improve the physical efficiency of COPD patients.[4] The benefits of pulmonary rehabilitation are improved exercise capacity, reduced perceived sensitivity of breathlessness, improved health-related quality of life (HRQOL), reduced number of hospitalisation, and improved arm function.[5]

A diagnosis of COPD should be considered in persons having chronic symptoms of cough, sputum production, shortness of breath, and/or wheezing, especially among those with prolonged exposure to risk factors for the disease. COPD patients may demonstrate various physical signs that may either be due to the primary disease or an associated complication.[1] The signs elicited in inspection are shortened inspiratory to expiratory (I: E) ratio, pursed lip breathing (PLB), use of accessory muscles, jugular venous distension, labored breathing signs, pulsus paradoxus, barrel-shaped chest, peripheral edema, dyspnea relieving posture and muscle wasting and during palpation subxiphoid shift of apex beat, restricted chest expansion. The findings seen

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Submission: 19-10-2018
Revision: 09-01-2019
Accepted: 21-05-2019
Published: 07-10-2019

How to cite this article: Solomen S. Guidelines for the physiotherapy management of chronic obstructive pulmonary disease. Physiother - J Indian Assoc Physiother 2019;13:66-72.

in percussion are hyperresonant in lung field, obliteration of cardiac dullness, lower level of liver dullness, and lower diaphragmatic levels. The auscultatory findings seen are diminished breath sound, early inspiratory crackles, loud pulmonic component in the second heart sound and rhonchi or wheeze in expiration.[6-8] Special maneuvers such as forced expiratory time and snider match test was also done in COPD patients. A forced expiratory technique (FET) of more than 6 s suggests airway obstruction.[9] In the snider match test, where the patient attempts to blow out a lighted match held 15 cm from the mouth and if the patient were unable to do so indicates severe ventilatory dysfunction.[10]

Pulmonary function test is a simple and accurate tool to assess airflow obstruction. In COPD patients, forced expiratory volume in 1 s (FEV_1)/forced vital capacity ratio is reduced, and FEV_1 is reduced. A reversibility testing differentiates COPD from asthma as in COPD patients do not show reversibility in airflow obstruction after administration of bronchodilators. As peak expiratory flow meter instrument is inexpensive, portable, and easy to operate and maintain, it has often been advocated as a surrogate measure for FEV_1. The radiological abnormalities associated with COPD are flattened diaphragm, hyperinflated lung fields, widened intercostal spaces, and tubular or boot-shaped heart. The differential diagnoses of COPD include asthma, congestive heart failure, bronchiectasis, tuberculosis, constrictive bronchiolitis, and diffuse panbronchiolitis.[1,11]

Severity staging of COPD is important for disease prognostication as well as for treatment. GOLD guidelines classify COPD into mild ($FEV_1 \geq 80\%$ predicted), moderate ($50\% \leq FEV_1 < 80\%$), severe ($30\% \leq FEV_1 < 50\%$), and very severe ($FEV_1 < 30\%$) disease.[12] Body-mass, airflow Obstruction, Dyspnea, and Exercise (BODE) index is also used for severity staging in COPD patients, but it is not known whether treatment can be tailored according to the BODE index.[13] Bhattacharjee *et al*.[14] conducted a study to find out the susceptibility of chronic obstructive pulmonary disease among bike riders in Bangalore using BODE index and concluded that more than 4 h of bike riding is associated with the chances of developing COPD even in nonsmokers; therefore, there is significant susceptibility of COPD among bike riders in Bangalore.

An evidence-based review conducted in 2012 determined the effectiveness and cost-effectiveness of pulmonary rehabilitation in the management of chronic obstructive pulmonary disease during acute exacerbation and stable phase. Seventeen randomized controlled trials on the effect of pulmonary rehabilitation on outcomes in stable COPD which met the inclusion criteria and were included in this review. The author concluded with moderate level of evidence as pulmonary rehabilitation, including at least 4 weeks of exercise training leads to clinically and statistically significant improvements in health-HRQOL in patients with COPD. Pulmonary rehabilitation also leads to a clinically and statistically significant improvement in functional exercise capacity. Five randomized controlled trials on the effect of pulmonary rehabilitation on outcomes following an acute exacerbation of COPD, which met the inclusion criteria and are included in this review. The author concluded that pulmonary rehabilitation (within 1 month of hospital discharge) after acute exacerbation significantly reduces hospital readmissions (relative risk, 0.50; 95% confidence interval, 0.33–0.77; $P = 0.001$) and leads to a statistically and clinically significant improvement in HRQOL.[5]

Physiotherapy Management of Acute Exacerbation of Chronic Obstructive Pulmonary Disease

An exacerbation of COPD is an acute event characterized by sustained worsening of any of the patient's respiratory symptoms (cough, sputum quantity and/or character, dyspnea) that is beyond normal day-to-day variation and leads to a change in medication, and where other causes of acute breathlessness have been clinically excluded. The precipitants of acute exacerbations of COPD (AECOPD) include infections, nonadherence to medication, or inhalation of irritants such as tobacco smoke or particles, and air pollution. Clinical features of exacerbation of COPD are characterized by symptoms such as reduction in activities of daily living and altered sensorium, labored breathing signs such as intercostal indrawing, Hoover's sign, supraclavicular indrawing and paradoxical chest wall movement, increase in heart rate (HR) and respiratory rate (RR), marked central cyanosis, reduced systolic blood pressure (BP), reduction in saturation needs the patient to be hospitalized. While elevated blood urea nitrogen, altered mental status, pulse >109 beats/min, age >65 years) score may help in deciding patients who need management in an intensive care unit. The differential diagnosis of AECOPD includes the 6Ps; pneumonia, pulmonary embolism, pneumothorax, pleural effusion, pulmonary edema (heart failure), and paroxysmal atrial tachycardia (arrhythmias). Medical management of exacerbation of COPD includes short-acting bronchodilators through inhaled route, oral glucocorticoids, antibiotics, and noninvasive ventilation (NIV). NIV should be used early in the management of respiratory failure due to AECOPD, in weaning from invasive mechanical ventilation, used even in settings where arterial blood gas monitoring is not routinely available. Continuous positive airway pressure, Bi-level positive airway pressure, and

intermittent positive airway pressure are the common mode used for noninvasive ventilation.[1]

Aims of physiotherapy for acute exacerbation of COPD are to reduce work of breathing (WOB), to control breathlessness, to assist in the removal of secretions, to reduce the amount and viscosity of secretions, and to facilitate accessory muscles. Amount and viscosity of secretions can be reduced by hydration, humidification, and nebulization. To reduce WOB, strategies such as positioning and oxygen therapy are administered. Breathing techniques such as breathing control, Innocenti, and PLB control the breathlessness. To facilitate accessory muscles, supported arm exercise can be given. To remove the excess secretions modified postural drainage, active cycle breathing technique (ACBT), and huffing techniques are administered.[15]

Hydration

Dehydration reduces mucus transport by 25%. If a patient is well hydrated, the secretions will be easily loosened up so it is better to advice the patient to drink warm water before chest physiotherapy.[8,16]

Nebulization

It is done to generate aerosol particles (suspension of liquid particles in a gaseous state). It is of two types: bland aerosol and therapeutic aerosol. The bland aerosol is the administration of saline which is commonly done to loosen the secretions before postural drainage. The therapeutic aerosol is the administration of the therapeutic dose of selected agents such as bronchodilators and mucolytics.[6,8,10,16]

Humidification

It is the method by which humidified (warming and moistening) air can be introduced into the respiratory system. In a COPD patient, humidification is done to humidify Oxygen while administering through cannula or through mask, to treat bronchospasm caused by cold air and to overcome humidity deficit when the upper airway is bypassed as in case of intubation.[6,8,16]

Facilitation of accessory muscles

During acute exacerbation of asthma or COPD, the patient's accessory muscles should be facilitated. An anterior pelvic tilt facilitates accessory muscle use. This can be achieved by placing a towel roll vertically along the spine in supine. Keeping hands on outstretched position in sitting also relieves breathlessness as it facilitates accessory muscles.[16,17]

Oxygen therapy

Oxygen therapy is administered in case of documented hypoxemia. The goal of inpatient oxygen therapy is to maintain PaO_2 ≥60 mmHg or SpO_2 ≥90% to prevent tissue hypoxia and preserve cellular oxygenation. Venturi mask is the oxygen delivery device of choice in AECOPD. The nasal cannula delivers a variable FIO_2 depending on the minute ventilation; the lower the minute volume, the higher the FIO_2. The nasal cannula can be used in AECOPD in those intolerant to Venturi mask, and after the acute phase of the exacerbation.[1,6,16]

Arm exercise

Supported arm exercise training is given during acute exacerbation of COPD. During supported arm training (the distal end of the extremity is fixed) this muscle can work as accessory muscles, and hence, there is less load on diaphragm muscles and hence less dyspnea. Supported arm training is commonly done with arm ergometer with training done at 60% of maximal work capacity, increase workload every 5th session as tolerated. The patient should do the exercise for 30 min.[16,18]

Modified postural drainage

Sometimes true postural drainage cannot be given in some conditions because they may desaturate or may develop orthopnea. In this case, modified postural drainage is adopted. For draining lower lobes, a pillow under the pelvis in supine may drain anterior basal segments, and a pillow under the pelvis in prone lying may drain posterior basal etc.[16,19]

Huffing

Huffing techniques are preferred compared to coughing techniques as coughing may further aggravate bronchospasm. Always huffing technique is interspersed with breathing control technique. One of the active coughing techniques such as pump coughing is also used as it facilitates secretion clearance in patients with air trapping.[16,20]

Electrical stimulation for peripheral muscle dysfunction

Weakness, atrophy, structural, and metabolic changes have been observed in limb muscles, which, in turn, can have a negative impact on exercise tolerance. This may initiate dyspnea deconditioning cycle. To break this, electrical stimulation can be applied. Studies have shown that electrical stimulation improves muscle function, exercise performance (increased walking distance and increased time to exhaustion in a constant work rate cycling test) and muscle size peak torque.[16,21,22]

TENS to reduce breathlessness

Studies have shown that the effect of single session of bilateral application of TENS for 45 min in patients with COPD showed increase in FEV_1, 6-min walk distance and decrease in dyspnea. An improvement in FEV_1 and dyspnea score at the end of Acu-TENS treatment was

associated with a concurrent increase in b-endorphin level in patients with COPD.[16,23,24]

At the Time of Discharge

An exercise testing is done at the time of discharge to prescribe exercise for the patient to perform in the home. A history of smoking history is noted, and smoking cessation therapy is administered at this time. This can minimize the future risk of disease progression.

Pacing

Pacing can be taught to get control of breathing during exercise. This is normally taught to patients at the time of discharge. This can decrease WOB and relieve dyspnea during activity. Subject and therapist simply test different I:E ratios with various activities such as cycling, walking, stair climbing until they find the rate and pattern that lower RR, relieves dyspnea, and possibly improves SaO_2. For example, while walking; for every two steps patient should exhale followed by the next step with patients inspiration.[16,25]

Smoking cessation

A smoking history, including pack-years or smoking index (number of bidis/cigarettes smoked per day multiplied by number of years smoked; mild, moderate, and heavy smokers are defined as having a smoking index of <100, 100–300, and >300, respectively should be documented for all patients with COPD. Smoking cessation is the most effective method to prevent COPD. The 5A strategy: ask (about tobacco use), assess the status and severity of use advice to stop, assist in smoking cessation, and arrange follow-up program should be adopted. In addition to a reduction in the rate of decline of FEV_1 in stable COPD, smoking cessation is also associated with a reduction in the frequency of exacerbations. Nicotine replacement therapies; forms such as gums, tablets, patches, and inhalers, drugs (varenicline or bupropion), are administered by physician to people who are planning to stop smoking.[26]

Exercise testing

The parameters of exercise prescription for the patient with chronic cardiopulmonary dysfunction are determined from a clinical exercise test. The purpose of this test is to determine how a patient exercise response differs from the normal and to diagnose the specific limitations to exercise. Exercise testing has to be done for both the upper limb and lower limb. In the lower limb, most commonly a 6-min walk test or shuttle walk test is preferred. However, in case of the upper limb, a supported upper limb exercise test with bicycle ergometer or unsupported upper limb endurance test to be performed. Whatever the tests administered, HR, BP, RR, Borg rate of perceived exertion (RPE) scale for breathlessness and fatigue has to be checked prior, immediately, and after 3 min of exercise testing. Commonly, these tests are performed at the time of discharge.[16]

Other airway clearance technique

Either ACBT or autogenic drainage (AD) is taught to the patient as home exercise at the time of discharge. ACBT consists of three phases breathing control, thoracic expansion, and FET. FET consists of low huffs and high huffs interspersed with breathing control. AD is a method of controlled breathing in which the patient adjust the rate location and depth of respiration. It is divided into three phases such as unsticky phase, collecting phase, and evacuating phase, whereas German approach has only one phase.[16,25]

Physiotherapy Management in Stable Phase

The goals in managing stable COPD include techniques to inhibit accessory muscles, to strengthen inspiratory muscles, to improve posture, to increase chest expansion, to improve the mobility of thorax, to improve the patients breathing pattern, prevention of exacerbations, and to reduce energy demand.[15]

Diaphragmatic breathing and incentive spirometry

Diaphragmatic breathing exercise and incentive spirometry are only given during stable phase not in the acute exacerbation as it may provoke the symptoms. Care should be taken that an inspiratory hold should not be given, as bullae may open up with inspiratory hold which can result in pneumothorax.

Other breathing techniques

Breathing control is synonymous with diaphragmatic breathing. However, the only difference is that in diaphragmatic breathing, it is done with maximal inspiration whereas in breathing control technique is performed at normal tidal volume. PLB exercise stresses on expiration, therefore, it can be used to control breathlessness and to reduce WOB. It keeps airways open by creating back pressure in the airways. The procedure is such that subject loosely purse the lips and exhale (like blowing out a match stick or candle). PLB decrease RR, increase tidal volume, improves exercises tolerance. Innocenti technique aimed to prevent forceful expiration thereby reduction of excess energy consumption and improves expiratory flow. The procedure is that at each breath instructs the subject to inhale just before abdominal muscle recruitment. This allows a smooth transition from inspiration to expiration practice first with physiotherapist's voice then without. It helps to prevent airway shutdown consumes less energy than PLB, thereby improving PaO_2.[16,25]

Techniques to inhibit accessory muscles

One of the techniques to inhibit the accessory muscle is that to give the accessory muscle its primary action rather than assisting in respiration. Hence that these muscles cannot take part in respiration and there will be shift of the respiratory work toward the diaphragm. For example, keeping the hand elevated overhead while breathing. Another way to inhibit accessory muscle is to keep the muscle either in fully lengthened or fully shortened position. Keeping the muscle in these positions cannot effectively actively part in respiration. For example, perform breathing with the neck in an elevated position. While performing breathing, give facilitatory techniques for lower thorax and inhibitory techniques for the upper thorax. This also inhibits the accessory muscle use. Applying the Myofascial release to accessory muscle also inhibits the muscle use. Positioning and unsupported arm exercises are the other ways to inhibit the accessory muscle, which is described below.

Positioning

During the stable phase, the pelvis should be posteriorly tilted pelvis to facilitate diaphragmatic muscle. This can be achieved by placing a pillow under the knees.[17,20]

Arm exercise

Unsupported arm training is given during the stable phase. During unsupported arm exercise, (the distal end is not fixed) the participation of the accessory muscles in ventilation decreases, and there is a shift of respiratory work to the diaphragm. This is associated with thoracoabdominal dyssynchrony, severe dyspnea, and termination of exercise at low workloads, especially in patients with more severe bronchial obstruction. Studies have shown that that upper limb exercise training for patients with COPD increases upper limb work capacity, improves strength and endurance, and reduces oxygen consumption at a given workload. The most common types of upper limb exercises are 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 the arm was above horizontal. Each exercise should be performed for 40 s followed by 20 s rest. Exercises have to be repeated four times in 4 min.[16,18]

Inspiratory muscle training

Inspiratory muscle training can be done by either through inspiratory threshold training or inspiratory resistive training. Inspiratory muscle training can be classified as low-pressure high flow loading or high-pressure low flow loading. In low-pressure high flow loading also called as normocapneic hyperpenic training increase the rate of breathing without altering $PaCO_2$ value. In this technique, subjects were asked to breath at the highest rate they can manage for 15–30 min. High-pressure low flow loading can be of two types; inspiratory resistive training or inspiratory threshold training. Studies have shown that it can decrease breathlessness, increase exercise tolerance, and increase nocturnal saturation. Even diaphragmatic training using weights can help in ventilatory muscle training.[16-18]

Endurance training

Aerobic endurance training can be performed at high or low intensity. High-intensity training (70%–85% of maximal work rate) improves aerobic fitness such as VO_2 max, delays anaerobic threshold, decreased HR for a given workload, increases oxidative enzyme capacity, and more capillarization of the muscle. It also improves exercise endurance. Low-intensity training improves the exercise endurance, but it does not improve aerobic fitness.[16,18]

Strength training

Strength training in stable phase of COPD leads to improvements in muscle strength, increased exercise endurance, and fewer symptoms during ADL. Lower-extremity strengthening may be augmented through aerobic training itself. Upper limb strengthening can be done with low resistance of light weights (dumbbells, pulleys, and elastic bands) and progressed first by increasing repetitions (starting with 10–20) before adding additional weight. During training physical therapist should monitor breathing pattern and pulse oximetry.[16,18]

Flexibility training

Patients with progressive chronic respiratory disease loose range of motion (ROM) of the shoulder, rib cage, and rib cage. This results in significant changes in posture and reduced mobility. Flexibility exercise can also be given in stable phase as it improves posture, increases ROM, decreases stiffness and prevents injury. Gentle stretching with body movements should be coordinated with breathing exercises. For example, movements that bring full shoulder flexion, back extension, and inspiration should be performed with trunk flexibility. Exercise with forward reaching and trunk flexion or with unilateral or bilateral hip flexion should be combined with expiration. Flexibility exercise is also incorporated in warm up and cool down period in the aerobic exercise to relieve muscle tension and anxiety.[16,18]

Buteyko technique

The Buteyko technique is performed by slowing RR with breath counting and at night, lying on the left side and taping mouth closed. The hold at the end of expiration elevates $PaCO_2$ which helps in bronchodilatation during stable phase. This technique reverses the symptoms, lessens the need for medication, and prevents attack on acute exacerbation.[8,16]

Postural correction exercise

A COPD patient typically exhibits a poked chin posture (flexion of the lower cervical column with the extension of the upper cervical column), rounded shoulder with kyphosis and sitting on an outstretched hand. Exercises such as chin tuck, neck extension, shoulder retraction, and back extension are prescribed for these patients at the stable phase.

Chest mobility exercise

Chest mobilization exercises can be defined as any exercises that combine active movements of the trunk or extremities with deep breathing. They are designed to maintain or improve mobility of the chest wall, trunk, and shoulder girdles when it affects ventilation or postural alignment. Commonly bilateral chest mobility exercise is administered for COPD patients.[15,16]

Whole body vibration

Whole body vibration was an efficacious mode of exercise training for people with stable COPD that did not negatively effect exercise tolerance or exacerbate the disease, while concurrently improving the functional performance of the lower limbs. During whole-body vibration training subjects exercise on a vibrating platform that produces sinusoidal oscillations. At high intensities, this vibration evokes muscle contractions on the entire flexor and extensor chain of muscles in the legs and all the way up to the trunk. Instead of voluntary muscle control like in common resistance training, the muscle contractions during high-intensity vibration training are caused by stretch reflexes. This training increases peripheral muscle strength and neuromuscular activation, especially of lower limbs, thereby increasing muscle force, exercise capacity, and quality of life in COPD patients.[27]

Energy conservation and work simplification technique

Energy conservation and work simplification refer to completing tasks in the most energy efficient way, to have enough energy for the activities you enjoy most. The rationale of energy conservation techniques is to reduce the unnecessary oxygen expenditure in the body. The three approaches to conserve energy is to increase awareness of how the activity is performed, to modify activity or use of assistive devices and by compensation through alternative methods or to increase dependence on others.[16,25]

Exhale with effort

Exhale with effort is employed only in most severely impaired subjects or those with greatest complaints of dyspnea. The procedure for this technique is to teach the subjects to break any activity into one or more breaths (bending, lifting, and getting out of bed).[16,25]

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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