Pol. Ann. Med., 2011; 18 (1): 177–187.

*OVERVIEW PAPER*

# REHABILITATION FOR CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

**Jolanta Olszewska**

*Department of Pulmonary Rehabilitation, Independent Public Center of Tuberculosis and Lung Diseases in Olsztyn, Poland*

**ABSTRACT**

**Introduction.** Chronic obstructive pulmonary disease (COPD) is recognized as one of the most frequent causes for hospitalization and disability, and one of the most prevalent diseases with a morbidity rate increasing worldwide. It is characterized by a not entirely reversible, usually progressive limitation of the air flow through the respiratory tract. It is associated with an abnormal inflammatory response in the lung to noxious particles or gas, most frequently triggered by tobacco smoking. Diagnosis of this disease must be objectified by accounting for the results of a lung function test (spirometry).

**Aim**. This paper aimed at emphasizing the role of rehabilitation in COPD treatment, discussing its scope, methods, program, and effects.

**Discussion.** Recently, the importance of rehabilitation in COPD management has increased significantly. It has been viewed as an integral part of the therapeutic procedure, equally important as pharmacological therapy and oxygen therapy. Pulmonary rehabilitation programs facilitate the control and subsidence of disease symptoms, enable the patient to achieve an optimal functional efficiency, limited only by the degree of disease progression, and improve the quality of life for COPD patients. It has been also noted that rehabilitation may decrease the costs of patients' social isolation, associated with respiratory dysfunction. Pulmonary rehabilitation, as a separate type of rehabilitation, was proposed in 1981 by the American College of Chest Physicians (ACCP). In the updated version of 2002, providing the guidelines devised by an international team of experts The Global Initiative for Chronic Obstructive Lung Disease (GOLD), pulmonary rehabilitation was recognized as an integral part of treatment.

Corresponding address: Jolanta Olszewska, Samodzielny Publiczny Zespół Gruźlicy i Chorób Płuc, ul. Jagiellońska 78, 10-357 Olsztyn, Poland; phone and fax: +48 89 532 29 76, e-mail: sekretariat@pulmonologia.olsztyn.pl

Received 8.11.2010, accepted 13.12.2010

**Conclusions.** Pulmonary rehabilitation has become a valuable, important and efficient element of COPD management, equal to that of pharmacological therapy and oxygen therapy.

**Key words:** chronic obstructive pulmonary disease (COPD), rehabilitation

## INTRODUCTION

According to the statement published in 2006 by the American Thoracic Society (ATS) and European Respiratory Society (ERS), at present pulmonary rehabilitation is defined as: an evidence-based, multidisciplinary, and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decreased daily life activities [13]. Chronic obstructive pulmonary disease (COPD) is currently considered not only as a respiratory system disease, but also as a systemic disease which affects the function of other organs, among others, the motor organ [9, 23]. Muscle training deficiency contributes to the setting off of the anaerobic mechanism at a lower work rate than normally. COPD patients frequently develop peripheral muscle dysfunctions. Thus, a "vicious circle" appears: physical activity is limited due to dyspnea, which then weakens the muscles and results in further exertional dyspnea at a lower work rate undertaken [2]. Muscular weakness affecting skeletal muscles and body mass loss are two major manifestations with respect to the systemic impact of this disease. It has been proved that being underweight definitely worsens the prognosis in COPD patients [3, 18].

Qualification criteria for rehabilitation include symptoms and their intensities, results of functional tests, and an assessment of comorbidities. Recommended qualification criteria for pulmonary rehabilitation are as follows: poor quality of life, limited participation in physical activities, decreased ability to work in one's profession, dependence on others concerning activities of daily living, increased health service use (hospitalizations), lung dysfunction, psychosocial disturbances (anxiety, depression) [2, 8].

Planning the rehabilitation process is preceded by an initial patient assessment, involving physical examination, interview, and additional examinations. The interview provides information with respect to the following aspects: symptoms intensity, nutrition, ability to perform activities of daily living, ability to perform exercises, and psychosocial situations. Devising an individual rehabilitation program is the final stage of the qualification process [5, 22].

In pulmonary rehabilitation, special attention should be paid to evaluating the degree of dyspnea. To this end, verbal scales (e.g., the Borg scale, American Thoracic Society scale – ATS scale) or visual scales (Visual Analog Scale – VAS) are used. The Borg scale incorporates 11 possible answers – lack of exertional dyspnea (0) to maximal dyspnea (10) [2, 5].

The ATS differentiates:
- I degree – dyspnea during a quick march on flat surface or uphill, or walking upstairs on the 1st floor – normal gait,
- II degree – dyspnea when keeping pace with a healthy peer on flat surface,
- III degree – dyspnea when walking on flat surface at one's own pace,
- IV degree – resting dyspnea [5].

Other symptoms considered for qualifying a patient and then monitoring his rehabilitation course include: coughing, sputum expectoration, and cardiovascular symptoms [2, 5].

Physical examination is the next stage of the initial patient assessment. It involves measuring and assessing the basic life functions (height, weight, blood pressure, heart rate, respiratory rate), activity of peripheral respiratory muscles, chest examination, evidence of hypertrophic pulmonary osteoarthropathy, swellings and other features of cardiac dysfunction. Physical examination is a simple, non-invasive method for evaluating, monitoring and controlling a patient's progress [2, 17]. Additional initial examinations are helpful in determining the initial clinical status of each individual patient and in devising a special rehabilitation program. These examinations are performed depending on the needs and decisions of that physician qualifying a patient for rehabilitation. They include: spirometry with bronchodilatator response, gasometry, pulsoxymetry, chest X-ray, stationary ECG, exercise tolerance test using cycle ergometer or treadmill, walk tests, and blood test [2, 5]. Spirometry provides information concerning the ventilation efficiency of the respiratory system, static and dynamic lung volumes, and lung capacities. Spirometric values, which reveal lung hyperinflation are more important [19]. Before beginning the rehabilitation program, all comorbidities or dysfunctions, which can influence the rehabilitation process, should be controlled or stabilized, and the treatment of the underlying disease should be optimized [1].

## AIM

This paper aims at emphasizing the role of rehabilitation in COPD treatment, discussing its scope, methods, program, and effects.

## DISCUSSION

### Pulmonary Rehabilitation Program

Pulmonary rehabilitation is based on education and kinesitherapy. Auxiliary function is attributed to physical therapy, including aerosol therapy, and psychosocial support and modification of lifestyle [9].

**Education.** In any chronic disease, thus also in COPD, the more the patient knows about its causes, course and treatment, the easier this treatment is. A well conducted education should motivate the patient to introduce such changes into his behavior as

will lead to improving his health and allow him to participate in the treatment process actively. Depending on the patient's individual needs, preparatory courses organized within the framework of a pulmonary rehabilitation program should cover the following topics: structure and function of the respiratory system, pathophysiology of lung disease, noxious agents (including tobacco smoking), interpretation of diagnostic tests results, breathing strategies (modification of the breathing pattern), bronchial tree hygiene, proper use of medication, principles of physical exercises, activities of daily living and energy conservation, prevention and early treatment of respiratory exacerbations, nutrition, psychosocial issues, including relaxation techniques [2, 5, 12].

**Physical Training.** Before beginning physical training, each patient's exercise capacity needs to be assessed. This aims at: assessing exercise capacity before the rehabilitation program and determining the recommended exertion, determining the initial level of physical efficiency in order to evaluate treatment results, detecting hypoxemia on exertion and determining oxygen therapy requirement, recognizing extrapulmonary limitations for taking up physical exercises (e.g., associated with muscular and skeletal systems, and/or cardiovascular system), detecting exercise-induced bronchoconstriction (EIB) [2, 5, 11]. Exercise tolerance tests are relatively safe for patients with no confirmed or diagnosed cardiac dysfunctions. These tests may vary, from simple and non-invasive to more complex, invasive and technically advanced. There is no one single protocol that could apply to all patients enrolled for various programs. The most frequently used tests are the 6-minute walk test (6MWT) and the exercise tolerance test using a treadmill or cycle ergometer performed according to a specific protocol. It is important to assess exercise tolerance in the same manner before and after the rehabilitation program. The simplest test evaluating exercise capacity is the 6MWT [5, 14, 19]. As already mentioned, muscular weakness and weight loss are the two major symptoms of the systemic influence of the disease. In COPD patients, muscular weakness affecting skeletal muscles is an independent factor contributing to limiting exercise tolerance, leading to functional deficits, increasing treatment costs and mortality risk. Thus, reversing a tendency of progressive weakness of muscular strength should be an important target in therapeutic procedure. Improving muscular strength and exercise tolerance can be achieved through adequate physical exercises. They underlie any activities of a well-planned rehabilitation course [10, 20]. Muscular training is based on endurance training and resistance training. Endurance training of the lower and upper limbs contributes to increasing exercise tolerance, even when no changes in spirometric parameters are observed. It can be performed in various forms: exercises with the use of arm and leg ergometer or on treadmill, or it can involve only walking on a flat surface. Lower limb training improves exercise tolerance and significantly diminishes dyspnea during activities of daily living, as well as associated stress and anxiety [5]. Until recently, upper limb training was considered as insignificant. It has since been proved, however, that

a simple exercise such as arm elevation without weights increases ventilation and metabolism in COPD patients. Coordinating inhaling and exhaling with a raising and lowering of the arms improves ventilation and involves the respiratory muscles, including peripheral inspiratory muscles. Resistance training increases muscle strength and mass. The best results are obtained when such training consists of several short series of exercises employing a large weight and repeated several times. It is better tolerated than endurance training [2, 5]. Most rehabilitation programs include endurance trainings or a combination of endurance and strength trainings, with sessions lasting 20–30 minutes, 2–5 times a week. Patients with more advanced stages of the disease, with a significantly limited exercise tolerance, may also participate in physical trainings. Such patients follow interval trainings (3 minutes of exercises, 3 minutes of rest). When the patient is able to perform ordered exercises for 30 minutes during one session, 3–5 times a week, the intensity of such training should be gradually increased [22].

**Breathing Strategies.** Breathing strategies aim at teaching a patient a mode of breathing which will involve a reduced respiratory rate combined with a bigger tidal volume. Commonly known breathing techniques include: exercises involving slow and deep breaths (contrary to a reflexive tendency to breath quickly when experiencing dyspnea episode), pursed lip breathing (reduces respiratory rate and the level of carbon dioxide, improves tidal volume and increases partial pressure of oxygen), and diaphragmatic breathing. Breathing exercises are conducted in appropriate body positions. Due to these, inhaling or exhaling may be facilitated or made more difficult; one section of the chest may be stabilized, whereas the other mobilized. Additionally, the activity of the diaphragm or intercostals may be increased during such exercises [2, 4, 6]. Before starting breathing exercises, it is necessary to learn how to do them properly. They should begin with inspiration. The ratio of inspiration, always through the nose, to expiration through the mouth should be 1 : 2, and sometimes even 1 : 3. The target is the maximal prolongation of expiration. Inspiration through the nose clears, warms and moistens the air, whereas expiration through the mouth increases its effectiveness and facilitates controlling its length. The number of repetitions of breathing exercises should not exceed 3 or 4 in a series. Breathing exercises performed too intensively may lead to hyperventilation, which can disturb acid-alkaline balance. It is better to repeat them more often, but less intensely [6]. The length of the entire training program involving pulmonary rehabilitation may vary. However, as was emphasized during The American Lung Association meeting in 2007, it should last from 6 to 12 weeks. A shorter length of training does not lead to an optimal improvement of physiological results, whereas longer continuation brings about insignificant long-term effects [5].

**Physiotherapy – methods provoking coughing and secretion removal.** Postural drainage is the classic method of respiratory tract hygiene. It involves positioning

the patient in such a way that a bronchus draining a given lung segment is vertical to the floor, and the drained segment above the pulmonary hilus. Depending on the location of the changes, various drainage positions are used (Fig. 1). Additionally, during this procedure, manual chest and back therapy may be performed, involving percussion (clapping), vibrations or shaking. Only those lung segments which are drained in a given moment are clapped or vibrated. This should be done towards the hilus, so that the separated secretion is removed more easily. This procedure can be performed 2–3 times a day for 30–40 minutes [4].

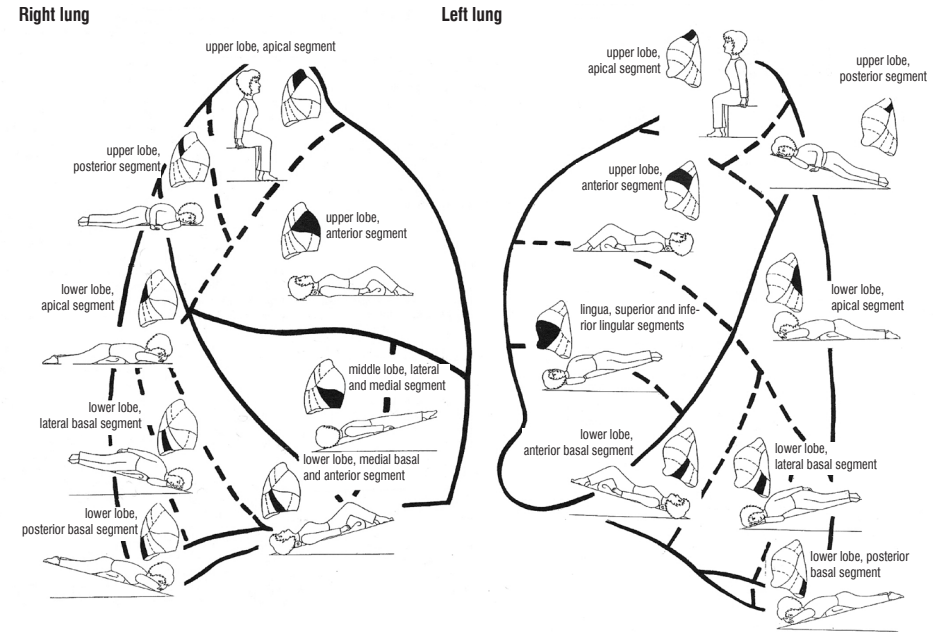


**Fig. 1.** Classic postural drainage positions [4]

**Autogenic Training**. This type of training refers to breathing with various tidal volumes, with holding the breath for a few seconds while inhaling [4].

A technique of changing end-expiratory pressure with the use of a Flutter device is based on producing a range of vibrations in the exhaled air. These vibrations are transmitted to the bronchial walls and the mucus adhering to them. This loosens mucus from the airway walls, which facilitates its being coughed up. When Flutter is placed downwards, the air resistance becomes smaller, when placed upwards – then the resistance is bigger. This device may be used in various positions assumed by the patient. The number of repetitions in a series is decided on an individual basis (from 3–4 to 8–10), depending on the respiratory capacity of the patient (Fig. 2) [4].

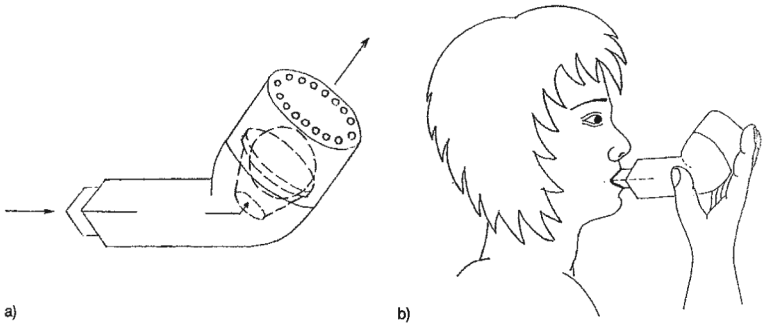


**Fig. 2.** Changing end-expiratory pressure with a Flutter device [4]

A technique of positive end-expiratory pressure requires the application of devices (Fig. 3) which enable changing expiratory pressure. Intensive air flow in the airways loosens mucus and provokes coughing which then removes it [4].

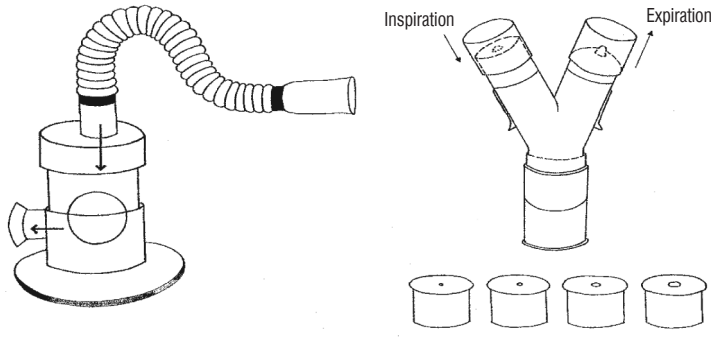


**Fig. 3.** Mediflo duo and Atemtrainer-set used in positive expiratory pressure technique [4]

Forced expiratory technique, also known as "huff coughing," consists of forced expirations with the glottis open. This intensive expiration is repeated twice or trice. While exhaling, stomach muscles may be activated, and chest muscles mobilized.

Active cycle of breathing techniques is based on controlled breathing (gentle breathing involving all respiratory muscles), thoracic expansion exercises (deep breathing with prolonged expiration, accompanied with percussion, vibrating massage and chest shaking) and forced expiratory technique (already discussed). The cycle of specific activities should be repeated for 15–30 minutes in each drainage position [4].

**Classic Massage.** Numerous authors emphasize the benefits of massage in physiotherapy performed on COPD patients. Classic massage (therapeutic, relaxing) in-

volves skin, muscles, ligaments, articular capsules, and periosteum. Local and generalized actions cause hyperemia, and as a result both skin temperature and blood flow rates increase, and the lymphatic system is activated. Consequently, tissue exchange is facilitated. Arterial blood pressure decreases, which leads to an increase in the heart rate. During massage, mucus in the airways is also loosened and coughing it up becomes easier. Vibrating massage is a form of classic massage, which involves transmitting high frequency vibrations to the patient's body by means of an electric device. It has been proved that the efficient frequency of vibrating massage, leading to the loosening up of mucus, should exceed 1100 cycles per minute [4].

**Physiotherapy.** Physiotherapy has an auxiliary function in COPD rehabilitation. The most frequently used physical therapy procedures include: inhalations (aerosol therapy), phototherapy, thermotherapy, electrotherapy, and ultrasound [5].

During aerosol therapy various types of therapeutic aerosols are introduced into the organism in order to affect the respiratory system. These aerosols may be natural or produced by medical devices. Natural methods include: inhaling sea spray, and breathing in the microclimate of salt mines or drifts. The aerosols used for inhalations can be divided into: bronchodilatation agents, expectorants, anti-inflammatory agents, antimycotic agents, and antibiotics. A proper mode of inhalation, especially proper breathing during this procedure is extremely important for its effectiveness. During inhalations, the patient should breathe slowly and deeply. A recommended respiratory rate is 5–6 breaths per minute, because the effectiveness of inhalations increases with a lowered respiratory rate. At 30 breaths per minute only 10% of inhaled aerosol is actively used, whereas at 5 breaths this usage increases to 60%. At the end of inspiration, the breath should be held for 3–5 seconds. Thus, all airflow in the airways is stopped completely and this contributes to the aerosol being deposited [17].

With respect to phototherapy, exposure to ultraviolet and infrared rays is applied (blue and red filters). These procedures aim at lowering muscle tone. They have an analgetic effect and increase tissue hyperemia. Ultrasounds and electrotherapy are used similarly. These types of therapy lower muscle tone, dilate blood vessels, block inflammations, and have an analgetic effect [2, 4].

**Psychosocial support.** Chronic lung disease may have a significant impact on a patient's quality of life and his family's life [10]. At the early stages of this disease, the patient and his family are frequently unaware of the disease or deny it and its severity. Contrary to the effects of other, well-known diseases, the debilitating effects of chronic diseases are not commonly known. Consequently, denying any relationship between respiratory symptoms and the previous or present behavior of the patient (e.g., tobacco smoking) is much easier. With disease progression, most patients experience fear and anxiety in anticipation of, and in association with, episodes of dyspnea. Moreover, heightened physiological arousal, accompanying the feeling of anxiety, can precipitate or exacerbate dyspnea. In the later stages of this disease, many

patients exhibit various psychosocial symptoms, reflecting their growing feelings of despair and inability to cope with their illness. Depression is frequently observed (51––74%), causing the following symptoms: sadness, despair, insomnia, loss of appetite, lowered willingness to act, lowered energy level, difficulties in concentration, leading to memory disturbances, and suicidal thoughts. Similar to fear and dyspnea, functional deficits may involve losing one's energy and motivation to undertake physical activity. This, consequently, leads to losing physical capacity, and a progressive disability [15, 21]. Mild to moderate neuropsychological impairments can appear both as a result of depression (as already noted) and hypoxemia. These disturbances are usually manifested as difficulties with concentration, poor memory, and cognitive dysfunction. Patients, who develop such disturbances, experience difficulties solving common problems associated with activities of daily life. They miss office or outpatient clinic appointments, and fail to adhere to the recommended therapy. That is why it is important to screen the patient for psychosocial dysfunctions. The evaluation of the patient's responses and direct observation of emotions should be complemented by the application of one of the tests specific for COPD: Saint George's Respiratory Questionnaire (SGRQ) and Chronic Respiratory Disease Questionnaire (CRQ) [5].

**Results Evaluation.** A comprehensive pulmonary rehabilitation program improves the quality of life for and the exercise capacity of COPD patients. Constant changes in health care, stressing the importance of quality, treatment costs and effectiveness, contribute to the fact that it becomes more significant to account for those indicators that reflect obtained rehabilitation results. In order to evaluate therapeutic results adequately, continuous quality control must be introduced into the pulmonary rehabilitation program. Such control facilitates the accomplishment of the targets schemed both for the individual patient and the program. Treatment results should be measured objectively so as to assess a patient's progress, as well as to evaluate the effectiveness of the rehabilitation program and medical staff activities. Patient-centered outcomes include: activities of daily living, health behavior, and participation in end-of-life decision making concerning the overall treatment strategy. Exemplary outcomes that can be monitored are as follows: change in exercise tolerance (6MWT performed before and after the program, pulmonary exercise test before and after the program, exercise diary kept for exercises performed at home, assessing muscle strength), change of symptoms (comparing dyspnea intensity, coughing frequency, sputum expectoration or wheezing, changes in body weight), other changes (activities of daily living, participant's knowledge before and after the program, frequency and length of disease exacerbations and hospitalizations, returning to professional activity) [2, 4, 9]. Pulmonary rehabilitation is a constant process aiming at changing one's life style. It begins when the patient is qualified for the program and lasts throughout the entire observation period. Follow-up examinations of patients who have completed the rehabilitation program are indispensable in order to ensure con-

stant improvement of their quality of life, up keeping their physical and functional activities. Various methods of controlling the patients and treating them after completed rehabilitation are used. These encompass: maintenance exercises programs, informing primary care physicians as to the patient's progress, support groups and educational groups, informative materials and leaflets concerning further treatment, phone controls and home visits made by a community nurse, and directing the patient to vocational rehabilitation centers [2, 7]. Continuing such activities after the completion of the program facilitates further improvement of a patient's quality of life and motivates him to constant work in achieving the aims schemed for him. A long-term support system by a multidisciplinary team of specialists inspires a patient to a maximum possible personal effort and an achievement of his own personal aims. Comprehensive pulmonary rehabilitation must take into account, also, further activities once the program is completed. This is one of the most important elements of rehabilitation [2, 4, 7, 22].

## CONCLUSIONS

Pulmonary rehabilitation has become a valuable, important and efficient part of COPD management, equal to that of pharmacological therapy and oxygen therapy. Thanks to a systematic and properly conducted physiotherapy, an improvement in physical capacity and respiratory effectiveness, an enlargement of the range of performed activities of daily living and a prolonging of the survival time are achieved.

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