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Pulmonary rehabilitation

Background

Key points

- There is a sound evidence base showing the effects of pulmonary rehabilitation on chronic obstructive pulmonary disease symptoms and health-related quality of life.
- Pulmonary rehabilitation may be carried out on an in- or outpatient basis, or in the patient's home – the outcome depends on the content of the programme and the quality of the team delivering it, rather than on the setting.
- Pulmonary rehabilitation is effective in patients with COPD after acute exacerbations as well as in the stable state.

Effective management of chronic pulmonary diseases aims to: 1) prevent progression; 2) relieve symptoms; 3) improve exercise tolerance; 4) improve health status; 5) prevent complications; 6) prevent exacerbations; and 7) reduce mortality. Pulmonary rehabilitation is a central aspect of the treatment of chronic obstructive pulmonary disease (COPD) and other chronic respiratory diseases, for which treatment other than smoking cessation and long-term oxygen therapy largely aims at improving symptoms. Pulmonary rehabilitation is a relatively recent practice in respiratory medicine and is described as an 'individually tailored and designed, multidisciplinary programme of care' for patients with chronic respiratory impairment. There are several guidelines that define pulmonary rehabilitation practice.

Definition

Pulmonary rehabilitation has been defined by the European Respiratory Society (ERS) and American Thoracic Society (ATS) as 'an evidence-based, multidisciplinary, and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decreased daily life activities. Pulmonary rehabilitation is designed to reduce symptoms, optimise functional status, increase participation, and reduce healthcare costs through stabilising or reversing systemic manifestations of the disease.'

Pulmonary rehabilitation should be included in the comprehensive treatment of COPD and other chronic respiratory diseases

Rationale

Patients with severe COPD become progressively less mobile and reduce their activities of daily living (ADL). Peripheral muscle wasting is a common finding and has a negative impact on survival. Gains in body weight, muscle mass and strength are associated with better exercise tolerance and longer survival; consequently, improving peripheral muscle function is an appropriate therapeutic target in patients with COPD. Physical activity is the strongest predictor of all-cause mortality in COPD patients, and increased activity is associated with better prognosis, physical and cognitive status, and survival. It is therefore not surprising that rehabilitation has a beneficial effect on symptoms and health-related quality of life (HRQoL) in stable COPD patients. Multidisciplinary rehabilitation can improve peripheral and respiratory muscle function, nutrition and ADL.

Application

According to Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, pulmonary rehabilitation should be offered to all COPD patients of stage II or greater severity. Professional societies, including the American College of Physicians (ACP), the American College of Chest Physicians (ACCP), the ATS and the ERS, recommend that clinicians should prescribe pulmonary rehabilitation for symptomatic patients with a forced expiratory volume in 1 s (FEV_1) of less than 50% of the predicted value, and should consider it for symptomatic or exercise-limited patients with an FEV1 greater than 50% of predicted. However, because of the high prevalence of GOLD stage II COPD or higher, healthcare systems are unable to meet the need for pulmonary rehabilitation in all eligible patients.

More information on COPD can be found in chapter 13.

Outcome

Published studies provide a sound scientific basis for the overall intervention, as well as its specific components (albeit at a lower level of evidence).

Clinical outcome

After rehabilitation, patients report improvement in HRQoL, a reduction in respiratory symptoms, increases in exercise tolerance and their ability to perform ADL, and greater independence. However, pulmonary rehabilitation has no effect on lung function or gas exchange (table 1).

Most COPD patients benefit from a pulmonary rehabilitation programme. Although some reports suggest that one-quarter to one-third of patients show no response, studies have failed to identify important predictors of treatment success or failure.

Health resources

Studies (mostly uncontrolled) evaluating the costs of pulmonary rehabilitation have reported a positive cost/benefit ratio, mostly due to a reduction in hospitalisation frequency after rehabilitation. A recent health economic analysis performed by the London School of Economics, the British Thoracic Society (BTS) and the Primary Care Respiratory Society UK (PCRS-UK) suggested that pulmonary rehabilitation is one of the most cost-effective treatments available. In fact, its cost per quality-adjusted life-year (QALY) is less than that of most long-term inhaled therapy.

Mortality

A large, prospective, controlled trial would be necessary to examine the possible effect of pulmonary rehabilitation on mortality, but given that a great deal of evidence already exists showing its health benefits, such a trial would be impossible to carry out as it would be considered unethical to deny rehabilitation to a control group. The effect of pulmonary rehabilitation on survival is therefore likely to remain unquantified. Nevertheless, as COPD patients with better exercise tolerance, less breathlessness and lower rates of hospitalisation have higher survival rates and pulmonary rehabilitation provides these benefits, it is reasonable to assume that it is likely to result in a survival advantage.

Outcome	Evidence for expected improvements
Breathlessness	+++
Exercise tolerance	+++
Health-related quality of life	+++
Health resource consumption	++
Respiratory muscle function	++
Survival	+
Lung function	-

Table 1 – Expected results of pulmonary rehabilitation. +++: based on randomised clinical trials and meta-analyses; ++: encouraging results but further evidence is needed; +: indirect evidence; -: no improvement.

Setting and content

Location

The principles of pulmonary rehabilitation apply regardless of location; consequently, it has been shown to be effective across the various settings studied so far, although few clinical trials offer direct comparisons between different settings.

Inpatient pulmonary rehabilitation may consist of a planned programme to which a patient is admitted directly, or care provided during an admission for an acute exacerbation. This clinical setting is better suited to patients with severe disease and/or a lack of home management support, or difficulties in transport to outpatient settings. Inpatient rehabilitation can provide similar benefits to those seen in outpatient settings. Potential disadvantages include the higher cost and, in some countries, lack of health insurance coverage.

Outpatient pulmonary rehabilitation is the most common setting employed, and can be based in the hospital or the community. Potential advantages include cost-effectiveness, a safe clinical environment and availability of trained staff. The majority of studies describing the benefits of pulmonary rehabilitation are derived from hospital-based outpatient programmes.

Home-based rehabilitation is the most convenient method for the patient. This method may prolong the benefits of rehabilitation, although in severely disabled patients, it might not be as effective. The potential disadvantages of home-based rehabilitation include the lack of opportunity for group support, limited presence of a multidisciplinary team, variable availability of exercise equipment, lack of safe facilities and the cost of visits by healthcare professionals.

Rehabilitation in the intensive care unit

Early mobilisation of critically ill patients is a relatively new management approach that is advocated as a method of addressing acute respiratory failure and reducing the disability associated with intensive care unit-acquired weakness. It has been shown that early physiotherapy benefits patients receiving intensive care. This therapeutic approach has been reported in clinical trials and is recommended by the ERS and the European Society of Intensive Care Medicine (ESICM) Task Force on Physiotherapy for Critically Ill Patients.

Availability and personnel

As outlined by the recent ERS COPD audit performed in 13 countries, 50% of European respiratory units have access to a pulmonary rehabilitation programme for patients with COPD after hospital admission but only 30% of eligible patients receive pulmonary rehabilitation. 35% of hospitals implement hospital-based pulmonary rehabilitation, 16% implement home-based rehabilitation and 30% implement both.

The effectiveness of pulmonary rehabilitation is more likely to be related to the structure and components of the programme and the quality of the team than to the setting in which it occurs. Pulmonary rehabilitation should be delivered by a multidisciplinary team that includes at least a physiotherapist, an occupational therapist, a psychologist and a dietician, although the exact structure will vary depending on patient population, programme budget and local reimbursement rules. The reported median availability of such personnel in Europe is two per respiratory

unit, with wide variations between countries. Overall, 60% of patients admitted to a respiratory unit are seen by a chest physiotherapist.

Components

The improvements attributable to individual elements of a programme are difficult to assess due to the multidisciplinary nature of pulmonary rehabilitation and to the wide range of therapeutic modalities used (table 2).

"50% of European respiratory units have access to a programme for patients with COPD, but only 30% of patients receive rehab"

Exercise training

Physical aerobic training, particularly of the lower extremities, is mandatory. Any patient capable of undergoing training will benefit from a programme that includes leg exercise. Most rehabilitation programmes include endurance training. In patients unable to tolerate high-intensity exercise, an alternative is interval training, which consists of 2–3 minutes of high-intensity training alternating with equal periods of rest. The optimal exercise intensity, modality, level of supervision, duration and maintenance programme remain to be determined. Although high-intensity training is often prescribed, lower-intensity physical training up to the tolerance level of the individual patient can still produce benefits; in fact, greater emphasis on individual prescription of the appropriate amount of exercise is recommended.

Although different exercise training programmes have been safely used in various respiratory diseases, they should not be considered in COPD patients until optimal medical control of the disease has been achieved. The varying severity and complexity of different COPD phenotypes suggest that different options should be used for training respiratory and/

Component	Evidence for expected positive results
Exercise training	+++
Supplemental oxygen during exercise	++
Breathing low-density gas mixtures	+
Mechanically assisted ventilation	+
Nutritional supplementation and advice	++
Anabolic steroids	+
Education	+
'Breathing retraining' techniques	-
Respiratory muscle training	++
Neuromuscular electrical stimulation	++

Table 2 – Components of pulmonary rehabilitation. +++: based on randomised clinical trials and meta-analyses; ++: encouraging results but further evidence is needed; +: indirect evidence; -: no improvement.

or peripheral muscles; thus, although it is not possible to generalise, modalities such as interval training, supported exercise and neuromuscular electrical stimulation have been proposed, in order to include the most disabled individuals.

Recent studies have shown that, following acute COPD exacerbations requiring hospital admission, pulmonary rehabilitation is associated with clinically meaningful improvement in exercise tolerance. Deterioration in performance after the event may be prevented by peripheral muscle training during acute care.

Adjunctive strategies to exercise

The effects of oxygen supplementation during exercise training are still being debated, although peripheral muscle function has been shown to deteriorate in COPD patients with long-term hypoxaemia. The results of oxygen supplementation during exercise training in patients with or without exercise hypoxaemia, in order to allow them to reach a higher exercise intensity, are also the subject of debate. The use of low-density gas mixtures to improve exercise performance in moderate-to-severe COPD patients is still under investigation.

There is experimental evidence that mechanically assisted ventilation may reduce breathlessness and increase exercise tolerance in COPD patients (allowing them to reach a higher exercise intensity), possibly by 'unloading' respiratory muscles and reducing 'air trapping' in the lungs – although the exact underlying pathophysiological mechanism remains unclear. In selected patients with severe chronic respiratory disease and suboptimal response to exercise, assisted ventilation may be considered as adjunctive therapy as it may allow for greater training intensity by unloading the respiratory muscles. However, delivering assisted ventilation during exercise is costly, very difficult and labour-intensive, and therefore should only be used in those who will particularly benefit from this therapy. Further studies are needed to further define its role in routine pulmonary rehabilitation.

Other interventions

Supportive strategies, including nutritional supplementation and advice, and/or pharmacological agents (*e.g.* testosterone or anabolic drugs), can help improve functional outcome, especially in patients suffering from weight loss and muscle wasting. The contribution of education alone remains unclear.

A physiotherapy technique that was previously used as part of rehabilitation encouraged patients to coordinate the breathing process; this technique now receives less emphasis. The term 'breathing retraining' generally refers to such techniques, including pursed-lip and diaphragmatic breathing. Pursed-lip breathing is often used subconsciously by COPD patients to enhance exercise tolerance in the face of severe breathlessness and increased ventilatory demand. Pursed-lip breathing results in slower and deeper breaths with a shift in respiratory muscle recruitment from the diaphragm to the accessory muscles of breathing, leading to decreased breathlessness and improved oxygenation on exercise. Physiological studies of diaphragmatic breathing have failed to show any benefits.

Respiratory muscle training increases the strength and endurance of the respiratory muscles. However, the beneficial effect of respiratory muscle training on the exercise capacity and ADL of COPD patients is still an issue of debate. A recent meta-analysis showed that inspiratory muscle training improves muscle strength and endurance, functional exercise capacity, dyspnoea and HRQoL in COPD patients. Inspiratory muscle endurance training has been shown to be less effective than respiratory muscle strength training. Most guidelines still do not recommend this as a method of training.

Neuromuscular electrical stimulation is a possible therapy method for patients with severe chronic respiratory disease who are bed-bound or suffering from extreme skeletal muscle weakness.

What is needed?

- Healthcare delivery systems should make conventional pulmonary rehabilitation available to all patients who are likely to benefit.
- Strategies for maintaining the benefits of pulmonary rehabilitation on a long-term basis are needed.
- Further research is required in order to optimise pulmonary rehabilitation. It should be tailored to the needs of the individual patient; the optimal schedule (intensity and duration of exercise training) should be defined; and the usefulness of other components beyond exercise should be clarified.
- More research is required in order to evaluate the benefits of pulmonary rehabilitation in respiratory diseases other than COPD.
- Telehealthcare in COPD seems to have an impact on the HRQoL of patients, reducing the frequency of hospital attendance. However, further research is needed to clarify its role as telehealthcare trials have included it as part of more complex packages.

Conclusion

Pulmonary rehabilitation reduces breathlessness, increases exercise tolerance and improves HRQoL in patients with COPD and other chronic respiratory diseases. Patients should be carefully selected in order to make the best use of resources and extract the maximum benefits from rehabilitation. Although unresolved questions remain, pulmonary rehabilitation programmes should be included in the comprehensive treatment of patients with COPD and other chronic respiratory diseases.

Further reading

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