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Pulmonary rehabilitation: what is it and why does it work?

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ABSTRACT Chronic lung diseases such as COPD are typically characterised by progressive disability arising from dyspnoea and reduced exercise capacity. Although the underlying cause of disability is the irreversible loss of lung function, there are compounding systemic complications, such as skeletal muscle dysfunction, that contribute. Pulmonary rehabilitation is a therapy that aims to improve physical functioning and health status without necessarily reversing the impairment of lung function. The key components of a pulmonary rehabilitation programme are individually prescribed physical training and self-management education. These therapies are delivered by a multi-professional team in a variety of settings. The physical training generally includes lower limb endurance and resistance exercises. Higher intensity training, where tolerated, will result in greater improvement though some gains can be achieved even with low intensity training. Pulmonary rehabilitation seems to work through a combination of genuine physiological training, reduced dyspnoea, and better self-management. Recent studies have now shown conclusively that a comprehensive pulmonary rehabilitation programme can produce improvements in walking performance and quality of life. These benefits translate to increased activities of daily living, reduced hospital length of stay, and possibly increased survival. Although pulmonary rehabilitation is effective and popular with patients it is not widely available. In future it will be necessary to explore ways of increasing capacity to meet demand.

KEYWORDS COPD, pulmonary rehabilitation

LIST OF ABBREVIATIONS Chronic obstructive pulmonary disease (COPD), Medical Research Council (MRC), National Institute for Clinical Excellence (NICE)

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Chronic respiratory diseases are generally characterised by progressive dyspnoea on exertion that eventually has a significant impact on physical functioning and quality of life. In most cases specific medical therapy cannot reverse the underlying condition and so the main aims of treatment must be to ameliorate the symptoms and reduce the impact of the disease on the patient and their family. In this context, the purpose of pulmonary rehabilitation is to limit the effects and consequences of disability in people with chronic lung disease. This is achieved through a programme of activities that include physical training and self-management education. This article will describe how this can be achieved and explain the nature and mechanisms of improvement where these are known. Most of the published literature about pulmonary rehabilitation is concerned with COPD, since this is the most common chronic respiratory condition. For practical purposes the same principles appear to apply to other chronic conditions such as asthma, bronchiectasis, or pulmonary fibrosis. Since the bulk of the literature is derived from COPD, we shall use that disease as the example condition here.

THE NATURE OF DISABILITY IN COPD

Progressive decline of airway function (FEV_1; forced expiratory volume in first second of maximal forced expiration from a position of full inspiration) in COPD will eventually result in symptoms of limiting dyspnoea. However, the relationship between decline of lung function and reduced exercise capacity is not very close. Some patients with severe airflow obstruction can retain reasonable function while others with reasonable spirometry may be significantly disabled. The reasons for this relate to a number of factors that might include the presence of dynamic hyperinflation or additional skeletal muscle dysfunction. The former appears to affect some people with COPD when the progressive rise in end-expiratory lung volume imposes a ventilatory limit on exercise. The skeletal muscle dysfunction appears to be a feature of advancing disease and may be the result of inactivity or a systemic manifestation of pulmonary inflammation. On balance, deconditioning is more likely since the skeletal muscles are not affected equally and can be improved by physical training. Continued inflammation may, however, still have a role in some patients. Reduced

Grade	Degree of breathlessness related to activities
1	Not troubled by breathlessness except on strenuous exercise.
2	Short of breath when hurrying or walking up a slight hill.
3	Walks slower than contemporaries on level ground because of breathlessness, or has to stop for breath when walking at own pace.
4	Stops for breath after walking about 100 m or after a few minutes on level ground.
5	Too breathless to leave the house, or breathless when dressing or undressing.

TABLE 1 Medical Research Council dyspnoea scale.

physical activity does not have a direct impact *per se* on quality of life, but will impair some activities of daily living and appears to be strongly related to prognosis. Other factors that have an impact on prognosis in COPD include the frequency of exacerbations and the damaging impact of hospital admissions. A successful pulmonary rehabilitation programme may be expected to have a positive and lasting impact on these things.

THE FEATURES OF A PULMONARY REHABILITATION PROGRAMME

Pulmonary rehabilitation comprises a programme of activities that must include individually prescribed physical exercise training and self-management education. The aim is to instill a sustained lifestyle change. The programme is generally provided by a team of professionals from different disciplines (e.g. medicine, nursing, physiotherapy, occupational therapy, etc.) and where possible should involve the relatives of the patient. Important considerations for discussion include the programme organisation, content, duration, site of delivery, and the assessment of outcome (see Figure 1).

Wherever they are delivered, rehabilitation programmes have similar stages of process and should be integrated into the total care of the patient. These stages include patient selection and recruitment, assessment, rehabilitation, reassessment, and maintenance. The selection of patients who might benefit from pulmonary rehabilitation is relatively simple. Rehabilitation appears to benefit all those who have significant disability. The British Thoracic Society statement and the NICE guidelines for COPD recommend that rehabilitation should be offered to those with an impaired MRC dyspnoea score (3–5) (see Table 1). Beyond that, the benefits of rehabilitation appear to be independent of age, starting disability, smoking status, or lung function. However, people with cognitive disability or locomotor problems may not be able to participate. It is expected that patients who are referred for rehabilitation have received optimum pharmacological treatment for their underlying condition.

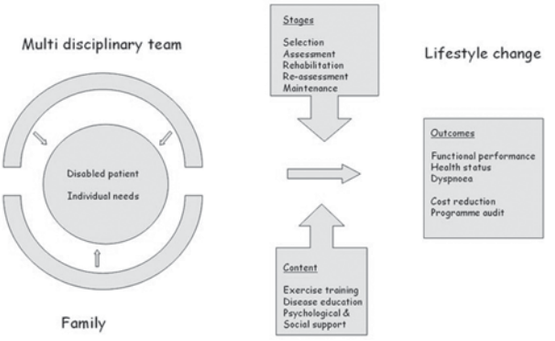

FIGURE 1 The concept of a pulmonary rehabilitation programme.

Once a patient is accepted on to a programme then their baseline status is assessed by some relevant measures that are later used as outcomes. Lung function is not a useful assessment measure since it is not expected to improve with rehabilitation. Tests of exercise performance and health status have much more relevance to the situation and are capable of improvement. Some thought is required when considering which exercise tests may be useful, since they do not all measure the same thing. We are accustomed to using the maximal incremental laboratory exercise for diagnostic testing or objective disability assessment. However a maximal laboratory performance is unlikely to improve much following rehabilitation, particularly if there is a ventilatory limit to exercise. Most rehabilitation programmes offer a mixture of lower limb strength and endurance training and in this situation endurance or constant workload tests are likely to be more sensitive. For practical reasons most programmes use field walking tests (Six Minute Walk Test, Shuttle Walk Tests) because they are easy to apply in any setting. Health status is assessed by sensitive generic or disease-specific quality of life questionnaires of which the St George's Questionnaire and the Chronic Respiratory Questionnaire are the most popular. The benefits of rehabilitation have been demonstrated though these proxy measures although the overall effects are probably better reflected in improved activities of daily living, better mood, and greater self-management skills. Recent studies have begun to use these outcomes that are germane to the intention.

Individually prescribed physical training of the large muscle groups is a mandatory component of rehabilitation. Absence of adequate physical training does not allow all the benefits of improved exercise capacity. Most programmes offer progressive lower limb aerobic endurance training by means of brisk walking or cycling. The prescribed intensity is gradually increased as the patient can manage and a reasonable target would be 85% of the initial maximal performance. The individual prescription and the rate of increment are determined by the supervising staff, ultimately aiming for a session duration of 20 minutes. The frequency of training should

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be at least two supervised sessions and up to three further additional home-based training periods. Most programmes will combine the endurance training with some additional lower and upper limb resistance training to enhance the benefit. The role of adjunctive specific respiratory muscle training remains uncertain.

Self-management and disease education are also key components of a rehabilitation programme. These generally include lectures and discussions about key topics including disease management, therapy, exacerbation management, relaxation, nutrition, sexuality, and other related topics. The involvement of the partner or carer is an important element in the success of this aspect of the programme.

The overall duration of a rehabilitation programme is a matter of continued debate. It is likely that patients will continue to accrue some benefits if the programme is continued indefinitely. However, most countries have to balance the benefit to the individual against the pressures of unmet demand, so an exploration of the minimum period of effective rehabilitation has been made. It appears that a minimum of four weeks outpatient rehabilitation is necessary to obtain acceptable results, though patients will continue to accrue benefits for some time afterwards through lifestyle change. The recognised benefits of pulmonary rehabilitation include improved exercise performance and health status together with greater domestic activity, reduced hospital length of stay, and a suggestion of increased survival. The benefits of rehabilitation appear to last for between 12 and 18 months and then return to baseline. However this duration of benefit should be set against the natural history of the patient with COPD and the context of poor life expectancy. It is not known for certain whether repeated rehabilitation or maintenance classes can extend this effect.

The site of rehabilitation has implications for planning. Successful programmes have been described in hospital inpatient and outpatient settings as well as in community hospitals, and even in the patient's own home. If conducted properly they all appear to be effective and the choice of setting will be determined primarily by local factors and commissioning preferences.

WHY DOES REHABILITATION WORK?

Rehabilitation is an important established therapy for many chronic diseases. However, it was not immediately obvious to early researchers that it had any value for patients with chronic lung disease. This was because there was no obvious improvement in lung function. Now that we realise where the benefits can be obtained, there have been a number of good quality randomised controlled trials and meta-analyses that have confirmed the positive effects. In fact, the scientific evidence in favour of rehabilitation is possibly the strongest of any discipline. The appreciation that COPD and other chronic lung diseases have a systemic nature helps us to understand why it can be effective. Physical training can reverse some of the resultant deconditioning and true physiological training effects can be demonstrated in skeletal muscle. In addition, desensitisation to dyspnoea occurs and improved efficiency of task performance allows people to achieve more within their own limitations. Better understanding of ill health improves the insight of sufferers and their relatives and helps in the development of coping strategies. All these factors can improve the lives of people with lung disease without necessarily extending survival.

THE FUTURE OF PULMONARY REHABILITATION

We know that rehabilitation works and is popular with patients. The biggest challenge in all countries is to provide sufficient capacity to provide for all those who might benefit. In the UK it has been estimated that we can provide rehabilitation for only about 2% of those who may benefit. In order to meet this challenge, simple rehabilitation services will need to be developed outside hospitals, within the community. Rehabilitation programmes do not have to be complex but should adhere to common agreed standards and perform regular audit to ensure quality control. From a scientific perspective the process of rehabilitation can be improved by enhancing training methods and examining the synergy with other established pharmacological and non-pharmacological therapy. Finally, the benefits of rehabilitation have become clear in the chronic stable patient but need to be applied on recovery from exacerbation or even during hospital admission.

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KEYPOINTS

- Chronic respiratory diseases, typified by COPD, have systemic consequences beyond the loss of lung function. In particular, skeletal muscle dysfunction can contribute to resultant disability.
- Pulmonary rehabilitation is a programme of activities that aims to improve physical functioning and quality of life in patients with chronic respiratory disease.
- Pulmonary rehabilitation programmes deliver individually prescribed physical exercise training and self-management education. The exercise training is a mandatory component of a successful programme.
- The benefits of rehabilitation can be expressed as improvements in walking distance, quality of life questionnaires, and reductions in task-associated dyspnoea and hospital length of stay. Some self-management studies record reduced frequency of hospital admissions. Improved survival is likely but not proven.
- The optimal content, duration, and sites of rehabilitation are being explored. Rehabilitation is popular with patients but the main barrier to widespread implementation is lack of capacity.

FURTHER READING

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PAST PRESIDENTS

Dr William Seller, MD, FRCPEd. FRSE (1798–1869)

William Seller was born in Peterhead in 1798, his father a successful merchant trading with the Baltic States, his mother said to have been a very beautiful girl of 16 when she married. Sadly she was widowed within a few years, left to bring up two daughters and an only son, William. What little money she had was lost when somewhat naively she took some bad advice. It was then that she decided to move to Edinburgh, earn a modest living and have her children educated.

Seller became a pupil of Benjamin Mackay who had a private school in Register Street before taking up an appointment as a teacher in the High School taking Seller and some other pupils with him. Seller was an outstanding pupil.

When he was accepted by the University of Edinburgh to study classics and philosophy before medicine, he obtained permission to work as a tutor to other boys, earning sufficient money to relieve his mother of all her financial problems as well as paying his own fees and expenses. On graduating MD in 1821, the first thing he did was to open a boarding house for medical students as well as continuing to tutor those able to pay him.

Seller was remembered as much for his natural charm and kindly humour as for his academic achievements and clinical skills. The Harveian Society, 'impressed with the potent influence of his quaint humour and cheery laugh', even conferred on him the honorary degree of Doctor Hilaritatis. He was renowned for his intellect, his encyclopaedic memory and the gentle way he questioned his students, always trying to be positive and constructive, even when their answers had been wrong.

He became a Fellow of the Royal College of Physicians of Edinburgh in 1836, was its President 1848–1850 subsequently becoming a Fellow of the Royal Society of Edinburgh. In fact he was honoured with a medal from the Royal Society for his memoirs on the life and writings of another President of the Royal College of Physicians of Edinburgh, Dr Robert Whytt (1714–1766). In addition to his position in the Harveian Society, he was President of the Medico-Chirurgical Society 1854–1856.

For many years, he served as a physician in the Royal Infirmary of Edinburgh and the Royal Public Dispensary, as well as lecturing on *materia medica* and dietetics. He was an examiner in medicine for the University of Edinburgh and for the College until shortly before his death. On one occasion when he was blamed for being too lenient with a candidate he replied: 'Your object in examining should be not to find out the ignorance but the knowledge of those whom you examine.'

By today's standards he wrote few papers, but those that he did have published reveal much about him and his interests. The topics range from acupuncture for lock-jaw to homeopathy; from the metaphysical aspects of physiology to the remedial uses of oils of turpentine and juniper; from the fatty heart to medicine as an art.

In May 1865, he lost his last surviving sister and soon thereafter developed jaundice. It was a long time before he sought medical advice for his increasing girth, lethargy and tendency to fall asleep. His friends Mr Archibald Dickson, FRCS, Sir James Young Simpson and Dr Alexander Wood agreed that he had massive hepatomegaly, ascites and eventually hydrothorax. Surprisingly he lingered on, only dying on 11 April 1869, aged 71. It is said that the President and every member of the Council of the Royal College of Physicians free to attend his funeral did so.

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