

# Pulmonary Rehabilitation for patients with Chronic Obstructive Pulmonary Disease

## Background

Pulmonary rehabilitation is an important aspect of the treatment of patients with chronic obstructive pulmonary disease with a view to improving breathing, exercise capacity, muscle strength, overall physical and mental well-being and health related quality of life.

Pulmonary rehabilitation is generally thought to be effective but questions such as the length of the programme, the effectiveness following an exacerbation of COPD, the best form of exercise to be used, the efficacy in the presence of co-morbidities, the use of alternative therapies and the value of an educational component, still need to be asked.

In 2013, a Thoracic Society Standards of Care Committee working group, chaired by Charlotte Bolton, developed an evidence based guideline for the conduct of pulmonary rehabilitation. That guideline provides an excellent, up to date, synopsis of best practice in pulmonary rehabilitation and a summary of its main findings is provided in the *reviews and overviews* section of this rapid review. Similarly, a 'Clinical Year in Review' session, focusing on the latest developments in pulmonary rehabilitation, held at the 2013 European Respiratory Society Annual Congress in Barcelona, resulted in a review of recent research by Martijn Spruit, summarised in the *reviews and overviews* section.

## Summary and key findings

- pulmonary rehabilitation programmes are effective overall in improving exercise capacity, dyspnoea, health status and psychological wellbeing
- pulmonary rehabilitation is an effective and safe intervention to reduce hospital admissions and mortality and to improve health-related quality of life in COPD patients who have recently suffered an exacerbation of COPD
- comprehensive pulmonary rehabilitation produces significantly better results than education alone and education programs do not improve on the results of exercise based pulmonary rehabilitation
- inclusion of Tai Chi in pulmonary rehabilitation shows a modest complementary benefit in exercise capacity while acupuncture shows a clear benefit in reducing dyspnoea on exertion.

- although short, three week programmes can have a positive effect on patients with acute exacerbation of chronic obstructive pulmonary disease, longer programmes provide greater benefits and early intervention leads to faster recovery of quality of life
- water based exercise programmes are more effective than land based exercise programmes in increasing peak and endurance exercise capacity and improving aspects of quality of life
- the supplemental use of home-based nocturnal non-invasive intermittent positive pressure ventilation (NIPPV) may improve health related quality of life, mood, dyspnoea, gas exchange, exercise tolerance and lung function decline.
- Muscle-wasted COPD patients with moderate airflow obstruction show a prolonged positive response to nutritional support

**Review of evidence**

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The reviewed evidence is listed in reverse chronological order with the most recent evidence first.

a) British Thoracic Society 2013 guideline on pulmonary rehabilitation in adults

Study	Findings														
<p>Bolton C E (Chair), Bevan-Smith E F, Blakey J D, Crowe P, Elkin S L, Garrod R, Greening N J, Heslop K, Hull J H, Man W D-C, Morgan M D, Proud D, Roberts C M, Sewell L, Singh S J, Walker P P and Walmsley S (2013) British Thoracic Society guideline on pulmonary rehabilitation in adults: accredited by NICE, <i>Thorax</i> 68 (Supplement 2) : ii1-ii30</p>	<p>In 2013, The British Thoracic Society published an evidence-based guideline on pulmonary rehabilitation in adults, summary recommendations from which are reproduced below...</p> <table border="1" data-bbox="1146 411 2024 1279"> <thead> <tr> <th colspan="2" data-bbox="1146 411 2024 464">Grades of recommendations</th> </tr> <tr> <th data-bbox="1146 464 1234 523">Grade</th> <th data-bbox="1234 464 2024 523">Type of evidence</th> </tr> </thead> <tbody> <tr> <td data-bbox="1146 523 1234 767">A</td> <td data-bbox="1234 523 2024 767">At least one meta-analysis, systematic review, or randomised controlled trial (RCT) rated as 1++ and directly applicable to the target population <i>or</i> A systematic review of RCTs or a body of evidence consisting principally of studies rated as 1+ directly applicable to the target population and demonstrating overall consistency of results</td> </tr> <tr> <td data-bbox="1146 767 1234 922">B</td> <td data-bbox="1234 767 2024 922">A body of evidence including studies rated as 2++ directly applicable to the target population and demonstrating overall consistency of results <i>or</i> Extrapolated evidence from studies rated as 1++ or 1+</td> </tr> <tr> <td data-bbox="1146 922 1234 1077">C</td> <td data-bbox="1234 922 2024 1077">A body of evidence including studies rated as 2+ directly applicable to the target population and demonstrating overall consistency of results <i>or</i> Extrapolated evidence from studies rated as 2++</td> </tr> <tr> <td data-bbox="1146 1077 1234 1150">D</td> <td data-bbox="1234 1077 2024 1150">Evidence level 3 or 4 <i>or</i> Extrapolated evidence from studies rated as 2+</td> </tr> <tr> <td data-bbox="1146 1150 1234 1279">✓</td> <td data-bbox="1234 1150 2024 1279">Important practical points for which there is no research evidence, nor is there likely to be any research evidence. The guideline committee wishes to emphasize these as Good Practice Points.</td> </tr> </tbody> </table>	Grades of recommendations		Grade	Type of evidence	A	At least one meta-analysis, systematic review, or randomised controlled trial (RCT) rated as 1++ and directly applicable to the target population <i>or</i> A systematic review of RCTs or a body of evidence consisting principally of studies rated as 1+ directly applicable to the target population and demonstrating overall consistency of results	B	A body of evidence including studies rated as 2++ directly applicable to the target population and demonstrating overall consistency of results <i>or</i> Extrapolated evidence from studies rated as 1++ or 1+	C	A body of evidence including studies rated as 2+ directly applicable to the target population and demonstrating overall consistency of results <i>or</i> Extrapolated evidence from studies rated as 2++	D	Evidence level 3 or 4 <i>or</i> Extrapolated evidence from studies rated as 2+	✓	Important practical points for which there is no research evidence, nor is there likely to be any research evidence. The guideline committee wishes to emphasize these as Good Practice Points.
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**The role of pulmonary rehabilitation**

- Pulmonary rehabilitation should be offered to patients with chronic obstructive pulmonary disease (COPD) with a view to improving exercise capacity by a clinically important amount. (Grade A)
- Pulmonary rehabilitation should be offered to patients with COPD with a view to improving dyspnoea and health status by a clinically important amount. (Grade A)
- Different components within a pulmonary rehabilitation programme, such as resistance training, can influence quadriceps strength and this is addressed in the section 'Nature of training of these guidelines'. (v)
- Pulmonary rehabilitation should be offered to patients with COPD with a view to improving psychological wellbeing. (Grade A)
- As a minimum, efficacy of pulmonary rehabilitation programmes needs to be regularly assessed by demonstrating clinically important improvements in exercise capacity, dyspnoea and health status. (Grade B)
- As part of regular assessment, patient satisfaction and feedback should be sought. (v)

**Referral and assessment of patients for pulmonary rehabilitation**

- The point of referral to pulmonary rehabilitation should be used as an opportunity to explore the patient's understanding of pulmonary rehabilitation, address concerns and to educate patients about the benefits of a pulmonary rehabilitation programme. (v)
- Healthcare professionals making referrals to pulmonary rehabilitation should have basic knowledge about what a programme entails and effectiveness. A pulmonary rehabilitation programme should be presented by the referrer as a fundamental treatment for COPD rather than an optional extra. (v)
- Initial assessment for pulmonary rehabilitation provides an opportunity to assess and refer for treatment of comorbidities prior to commencing. (v)
- The setting of pulmonary rehabilitation, skill mix of the team and other comorbidities should always be considered in the risk assessment of patients entering a rehabilitation programme. (v)

**Specific situations at assessment**

## Smoking

- Patients with COPD should be referred for pulmonary rehabilitation regardless of their smoking status. (Grade D)
- Patients referred to pulmonary rehabilitation should have their smoking status assessed and referral to smoking cessation services offered to smokers simultaneously. (v)
- Pulmonary rehabilitation provides opportunities to offer smoking cessation advice. (v)

## Chronic respiratory failure

- Patients with COPD can be referred for pulmonary rehabilitation regardless of whether or not they have chronic respiratory failure. (Grade D)
- When considering the referral of patients with chronic respiratory failure, practitioners should reflect on the receiving setting and skill mix of the attending staff to provide safe pulmonary rehabilitation to these patients who have significant physiological impairment and potential for greater instability by the intended programme. (v)

## Cardiovascular disease comorbidity

- People with chronic respiratory disease should be referred to pulmonary rehabilitation irrespective of coexistent stable cardiovascular disease. (Grade D)
- A coexistent abdominal aortic aneurysm (AAA) <5.5 cm should not preclude referral to pulmonary rehabilitation and being included in moderate intensity aerobic exercise training, provided blood pressure is controlled. (Grade D)
- The referral process and/or the initial assessment for pulmonary rehabilitation offer an important opportunity to assess and optimise cardiovascular health and address risk factors for cardiovascular disease. (v)
- In patients with COPD who have an AAA >5.5 cm, deemed not fit for surgery, pulmonary rehabilitation incorporating mild–moderate intensity aerobic exercise may be considered, but should not include resistance training. (v)

#### Anxiety and depression

- Coexistent symptoms of anxiety and/or depression in patients with COPD should not preclude referral to pulmonary rehabilitation. (Grade D)
- The referral process and the assessments for pulmonary rehabilitation offer important opportunities to detect and consider referral for ongoing support and management for depression. (v)

#### MRC dyspnoea scale

- Patients with a Medical Research Council (MRC) Dyspnoea score of 3–5 who are functionally limited by breathlessness should be referred for outpatient pulmonary rehabilitation. (Grade A)
- Patients with a MRC dyspnoea score of 2 who are functionally limited by breathlessness should be referred for pulmonary rehabilitation. (Grade D)
- Patients with a MRC dyspnoea score of 5 who are housebound should not routinely be offered supervised pulmonary rehabilitation within their home. (Grade B)
- Flexible and pragmatic approaches should be considered to facilitate exercise training in patients who have less severe COPD and who are less breathless. (v)

#### Bronchodilator therapy

- Patients with COPD should be taking bronchodilator therapy in line with National Institute for Health and Clinical Excellence (NICE) COPD guidelines prior to referral to pulmonary rehabilitation. (Grade D)
- Pulmonary rehabilitation offers an opportunity to check and optimise inhaler technique. (v)

#### Other considerations regarding referral to pulmonary rehabilitation

- Patients with unstable cardiac disease or locomotor difficulties that preclude exercise (eg, severe arthritis or severe peripheral vascular disease) should not be referred for pulmonary rehabilitation. (v)
- Careful consideration should be given to patients who have significant cognitive or psychiatric impairment that would lead to an inability to follow simple commands in a group setting. (v)
- In certain individual cases, facilitation of pulmonary rehabilitation may be aided by the support and attendance of a relative or carer. (v)
- In case of doubt over the appropriateness of a patient for pulmonary rehabilitation, clinicians are advised to contact their local provider. (v)

**Structure of pulmonary rehabilitation**

- Frequency of supervised pulmonary rehabilitation sessions . Pulmonary rehabilitation programmes should be a minimum of twice-weekly supervised sessions. (Grade D)
- In line with published pulmonary rehabilitation studies and the outcomes they demonstrate, a third session of prescribed exercise is recommended. This can be performed unsupervised. (v)
- Encouragement of regular physical activity five times a week for 30 min each time is encouraged in line with standard healthy living advice. (v)

**Duration of pulmonary rehabilitation programmes**

- Pulmonary rehabilitation programmes of 6–12 weeks are recommended. (Grade A)
- Pulmonary rehabilitation programmes including the attendance at a minimum of 12 supervised sessions are recommended, although individual patients can gain some benefit from fewer sessions. (Grade A)
- If training for less than 6 weeks is considered, this should be individualised and objective/subjective measures of benefit in place before patients graduate. For some individuals, reassessment at 4 weeks and graduation to independent gym training is a feasible possibility. (v)

**Rolling or cohort programmes**

- Cohort or rolling programmes of pulmonary rehabilitation are both acceptable forms of delivery depending on local considerations. (Grade D)

**Nature of training**

- To ensure strength and endurance benefits in patients with COPD, a combination of progressive muscle resistance and aerobic training should be delivered during a pulmonary rehabilitation programme. (Grade B)
- Relevant expertise is required to deliver resistance training. (v)
- Patients should be capable of continuing effective resistance training once supervised sessions have ended. The supervising rehabilitation therapist should ensure that patients are able and willing to continue with unsupervised resistance training. (v)
- Prescribing of progressive strength exercise should be individualised for each patient, taking into consideration the initial health screening and any increase in risk from comorbidities. (v)



**Interval and continuous aerobic training**

- Interval and continuous training can be applied safely and effectively within the context of pulmonary rehabilitation to patients with COPD. (Grade A)
- The choice of interval or continuous training will be down to the patient and/or therapist preference. (v)
- In clinical practice, interval training may require a higher therapist to patient ratio to ensure adequate work rate and rest intervals are achieved compared with continuous training. (v)

**Goal setting in pulmonary rehabilitation**

- Generic exercise training as opposed to individually targeted exercise training is recommended for pulmonary rehabilitation. (Grade D)
- While generic exercise training is recommended as opposed to an individually targeted exercise programme, the prescription of exercise is individualised to provide correct intensity. (v)
- Besides the exercise elements of pulmonary rehabilitation, healthcare professionals commonly use goal setting to address specific hurdles. Given the personalised nature of this intervention to a patient's needs, evidence is difficult to quantify. (v)
- The term 'goal setting' may require discussion with the patient. (v)

**Supervision in pulmonary rehabilitation**

- A supervised pulmonary rehabilitation programme is recommended for patients with COPD. (Grade A)
- If considering a structured home-based rehabilitation programme for patients with COPD, the following important factors need careful consideration: mechanisms to offer remote support and/or supervision, provision of home exercise equipment and patient selection. (Grade B)
- There would be some benefit to increasing the options for pulmonary rehabilitation available to individuals with
- COPD, and increase the scope of the service. Geography may limit or stimulate options. (v)

**Post-exacerbation pulmonary rehabilitation Outcomes in post-exacerbation pulmonary rehabilitation**

- Patients hospitalised for acute exacerbation of COPD should be offered pulmonary rehabilitation at hospital discharge to commence within 1 month of discharge. (Grade A)
- Providing post-exacerbation pulmonary rehabilitation alongside elective pulmonary rehabilitation courses can cause practical issues. Evaluation of innovative ways of delivering a combination of both modes of pulmonary rehabilitation in tandem would be useful. (v)

**Completion of post-exacerbation pulmonary rehabilitation**

- Clinical services providing post-exacerbation pulmonary rehabilitation commencing within 1 month of hospital discharge should carefully record uptake, adherence and completion rates. (Grade D)
- Patients who initially decline pulmonary rehabilitation commencing within 1 month of hospital discharge should be offered elective pulmonary rehabilitation. (Grade D)

**Adjuncts to pulmonary rehabilitation**

## Inspiratory muscle training and pulmonary rehabilitation

- Inspiratory muscle training (IMT) is not recommended as a routine adjunct to pulmonary rehabilitation. (Grade B)

## Hormones and nutritional supplements and pulmonary rehabilitation

- No specific hormonal or nutritional supplement can currently be recommended as a routine adjunct to pulmonary rehabilitation. (Grade B)
- The optimal approaches for addressing malnutrition, sarcopenia or obesity in COPD are uncertain and this is a wider issue than this guideline covers. However, attendance at a pulmonary rehabilitation course presents an ideal opportunity to screen and educate patients on nutrition. (v)
- Patients with a body mass index (BMI) in the underweight or obese range should be considered for specific dietetic support. (v)

## Non-invasive ventilation during pulmonary rehabilitation

- Long-term domiciliary non-invasive ventilation (NIV) should not be provided for the sole purpose of improving outcomes during pulmonary rehabilitation. (Grade D)
- Patients who already receive long-term domiciliary NIV for chronic respiratory failure should be offered the opportunity to exercise with NIV during pulmonary rehabilitation if acceptable and tolerable to the patient. (Grade D)

## Supplemental oxygen in patients undergoing rehabilitation

- Supplemental oxygen should not be routinely used for all patients undergoing pulmonary rehabilitation. (Grade B)
- Supplemental oxygen during pulmonary rehabilitation should be offered to those who fulfil the assessment criteria for long-term or ambulatory oxygen unless there are compelling clinical reasons to use alternative criteria. (Grade D)
- Individuals who are prescribed oxygen but decline to use it during exercise should have this clearly documented in their notes. (v)
- Pulmonary rehabilitation provides an opportunity to assess the adequacy of the prescribed flow rate for patients already in receipt of long-term oxygen therapy (LTOT) or ambulatory oxygen. (v)

#### Supplemental heliox in patients undergoing rehabilitation

- Heliox should not be used as an adjunct to pulmonary rehabilitation unless there are comorbidities which require its administration. (Grade D)

#### Neuromuscular electrical stimulation and pulmonary rehabilitation

- If expertise in neuromuscular electrical stimulation (NMES) is available, selected patients (low BMI with evidence of quadriceps weakness) who are unable or unwilling to participate in pulmonary rehabilitation could be considered for NMES. (Grade D)

#### **Pulmonary rehabilitation in people with other chronic respiratory diseases**

##### Non-cystic fibrosis bronchiectasis

- Patients with non-cystic fibrosis (CF) bronchiectasis who have breathlessness affecting their activities of daily living (ADL) should have access to and be considered for pulmonary rehabilitation. (Grade D)
- Unlike in patients with CF, in patients with COPD and non-CF bronchiectasis with multidrug-resistant organisms, for example *Pseudomonas aeruginosa*, there is no current evidence of cross infection. (v)

##### Interstitial lung diseases

- The benefits of exercise and the recommendation of incorporating exercise activities into a healthy lifestyle should be discussed with all patients with interstitial lung disease (ILD). Such discussion needs to be tailored to realistic achievability for that person's condition. (v)
- If healthcare professionals consider referring certain patients with stable ILD who are limited by breathlessness in ADL to pulmonary rehabilitation, they should discuss with the patient the likely benefits. (v)
- Patients with idiopathic pulmonary fibrosis (IPF) have a potential for significant desaturation during exercise related activities. (v)

##### Asthma

- The routine referral of patients with asthma to pulmonary rehabilitation is not recommended. (Grade D)
- The benefits of exercise and the recommendation of incorporating exercise activities into a healthy lifestyle should be discussed with all patients with asthma. (v)
- If healthcare professionals consider referring certain patients with stable asthma who are limited by breathlessness in ADL to pulmonary rehabilitation when on optimal therapy, they should discuss with the patient the likely benefits. (v)
- The British Thoracic Society (BTS)/Scottish Intercollegiate Guidelines Network (SIGN) asthma guideline draws attention to exercise-induced asthma and precautions to prevent this should be followed if appropriate. (v)

**Other chronic respiratory diseases—in general**

- Minimal clinically important different (MCID) changes and tools used to assess exercise capacity and quality of life for pulmonary rehabilitation in COPD are not necessarily transferable to other chronic respiratory diseases. While future research should address this, failure of rehabilitation should not be implied if failure to reach the COPD MCID for outcomes. (v)
- The educational element of pulmonary rehabilitation should be adapted for other chronic respiratory diseases if appropriate. (v)
- Practically, inclusion of patients with other chronic respiratory diseases into pulmonary rehabilitation will be alongside subjects with COPD. (v)
- General exercise should be encouraged for all patients with chronic respiratory disease. (v)

**Post pulmonary rehabilitation**

- Repeat pulmonary rehabilitation programmes . Repeat pulmonary rehabilitation should be considered in patients who have completed a course of pulmonary rehabilitation more than 1 year previously. The likely benefits should be discussed and willing patients referred. (Grade B)
- Earlier repeat pulmonary rehabilitation should be considered in individuals with accelerated physiological decline or if additional benefits on a shorter timescale would be clinically valuable. (Grade D)
- It is unlikely that if the patient completed the pulmonary rehabilitation course originally and failed to gain a benefit, they would benefit a second time round, unless circumstances such as an exacerbation interrupted the initial programme. (v)

**Maintenance**

- All patients completing pulmonary rehabilitation should be encouraged to continue to exercise beyond the programme. (Grade A)
- Patients graduating from a pulmonary rehabilitation programme should be provided with opportunities for physical exercise beyond their rehabilitation programme. (v)

## b) Other reviews and overviews

Study	Findings
<p>Spruit M A (2014) Pulmonary rehabilitation, <i>European Respiratory Review</i> 23 (131) : 55-63</p>	<p>This review summarised some of the main findings of peer-reviewed articles focusing on pulmonary rehabilitation that were published in the 12 months prior to the 2013 European Respiratory Society Annual Congress in Barcelona. The reviewed findings included...</p> <ul style="list-style-type: none"> <li>• short-term and long-term improvements in exercise capacity did not transfer into increased daily physical activity in patients with COPD</li> <li>• comorbidities are present in about 50–60% of patients with COPD entering pulmonary rehabilitation with five clusters: less comorbidity, cardiovascular, cachectic, metabolic, and psychological</li> <li>• dyspnoeic, non-hypercapnic patients with COPD and well-established chronic heart failure with reduced left ventricular ejection fraction (&lt;40%) have impaired cerebral oxygenation during progressive exercise compared to their COPD peers without chronic heart failure</li> <li>• water-based exercise training was significantly more effective than land-based exercise training and the non-exercising control group in improving incremental and endurance shuttle walk distances, and improving aspects of quality of life in patients with COPD with physical comorbidities</li> <li>• pulmonary rehabilitation during and directly following hospitalisation because of a COPD exacerbation has shown to be very beneficial and cost-effective for patients with COPD</li> <li>• the use of long-term oxygen therapy and living alone have been identified as independent predictors of poor attendance in patients with stable COPD, whereas current smoking, poor shuttle walk distance and hospitalisation are independent predictors of poor adherence to pulmonary rehabilitation</li> <li>• most patients with COPD experience a ventilatory limitation during the performance of whole-body endurance exercise training. Training of specific, smaller, lower limb muscle groups will reduce the ventilatory load and, in turn, may increase training load and muscle adaptations</li> </ul>

	<ul style="list-style-type: none"> <li>• a comparison between conventional linear exercise training and non-linear periodised exercise training shows non-linear exercise training seems beneficial for patients with very severe COPD</li> <li>• neuromuscular electrical stimulation is effective in counteracting quadriceps muscle dysfunction</li> <li>• balance training as part of pulmonary rehabilitation seems feasible and effective in patients with COPD</li> </ul>
<p>Ricci C, Terzoni S, Gaeta M, Sorgente A, Destrebecq A and Gigliotti F (2014) Physical Training and Noninvasive Ventilation in COPD Patients: A Meta-Analysis, <i>Respiratory Care</i> 59 (5) : 709-717</p>	<p>The first aim of this meta-analysis was to evaluate exercise training with noninvasive ventilation in terms of physiologic effects after the completion of a pulmonary rehabilitation program. The second aim was to investigate the dose-response relationship between physical improvement and training intensity.</p> <p>Eight studies provided a proper description of a training schedule in stable COPD patients. A similar effect between NIV and placebo was observed for the outcomes considered despite differences between studies. However, subjects experienced a relevant and statistically significant improvement after rehabilitation for almost all of the outcomes considered. Heart rate (6 beats/min [95% CI 0.94–11.01], <math>P = .02</math>), work load (9.73 W [95% CI 3.78–15.67], <math>P &lt; .001</math>), and oxygen consumption (242.11 mL/min [95% CI 154.93–329.9], <math>P &lt; .001</math>) significantly improved after training. Improvements in heart rate and work load were significantly correlated to training intensity.</p>
<p>Ng L W C, Mackney J, Jenkins S and Hill K (2012) Does exercise training change physical activity in people with COPD? A systematic review and meta-analysis, <i>Chronic Respiratory Disease</i> 9 (1) : 17-26</p>	<p>A systematic review and meta-analysis to examine the effect of exercise training on daily physical activity (PA) in people with chronic obstructive pulmonary disease (COPD).</p> <p>Study quality for the randomised trials (RTs) and single-group interventional studies was rated using the PEDro scale and Downs and Black Tool, respectively. No randomised controlled trials met the study criteria. The two RTs had a mean PEDro score of 5. The 5 single-group studies had a mean Downs and Black score of <math>19 \pm 3</math>. When combined, a small effect on PA outcomes was demonstrated (overall mean effect = 0.12; <math>p = 0.01</math>). Taken together, the RTs and single-group studies demonstrate that exercise training may confer a significant but small increase in PA.</p>

<p>Beauchamp M K, Janaudis-Ferreira T, Goldstein R S and Brooks D (2011) Optimal duration of pulmonary rehabilitation for individuals with chronic obstructive pulmonary disease - a systematic review, <i>Chronic Respiratory Disease</i> 8 (2) : 129-140</p>	<p>A review to determine the impact of duration of pulmonary rehabilitation on measures of health-related quality of life and exercise tolerance in individuals with chronic obstructive pulmonary disease (COPD).</p> <p>Three trials reported a difference in health-related quality of life in favour of the longer duration program; two trials reported a benefit in exercise capacity in favour of longer programs. A meta-analysis of results was not possible due to considerable heterogeneity in program duration and outcomes.</p> <p>Longer duration pulmonary rehabilitation programs appear to have a more favourable effect on health-related quality of life in individuals with COPD; results for exercise capacity are less clear.</p>
<p>Puhan M A, Gimeno-Santos E, Scharplatz M, Troosters T, Walters E H and Steurer J (2011) Pulmonary rehabilitation following exacerbations of chronic obstructive pulmonary disease, <i>Cochrane Database of Systematic Reviews</i> 2011, Issue 10. Art. No.: CD005305.</p>	<p>To assess the effects of pulmonary rehabilitation after COPD exacerbations on future hospital admissions (primary outcome) and other patient-important outcomes (mortality, health-related quality of life and exercise capacity).</p> <p>The review identified nine trials involving 432 patients. Pulmonary rehabilitation significantly reduced hospital admissions (pooled odds ratio 0.22 [95% CI 0.08 to 0.58], number needed to treat (NNT) 4 [95% CI 3 to 8], over 25 weeks) and mortality (OR 0.28; 95% CI 0.10 to 0.84), NNT 6 [95% CI 5 to 30] over 107 weeks).</p> <p>Effects of pulmonary rehabilitation on health-related quality of life were well above the minimal important difference when measured by the Chronic Respiratory Questionnaire (MD for dyspnoea, fatigue, emotional function and mastery domains between 0.81 (fatigue; 95% CI 0.16 to 1.45) and 0.97 (dyspnoea; 95% CI 0.35 to 1.58)) and the St. Georges Respiratory Questionnaire total score (MD -9.88; 95% CI -14.40 to -5.37); impacts domain (MD -13.94; 95% CI - 20.37 to -7.51) and for activity limitation domain (MD -9.94; 95% CI -15.98 to -3.89)). The symptoms domain of the St. Georges Respiratory Questionnaire showed no significant improvement. Pulmonary rehabilitation significantly improved exercise capacity and the improvement was above the minimally important difference (six-minute walk test (MD 77.70 meters; 95% CI 12.21 to 143.20) and shuttle walk test (MD 64.35; 95% CI 41.28 to 87.43)). No adverse events were reported in three studies.</p> <p>Authors' conclusion: Pulmonary rehabilitation is a highly effective and safe intervention to reduce hospital admissions and mortality and to improve health-related quality of life in COPD patients who have recently suffered an exacerbation of COPD.</p>

<p>Keating A, Lee A and Holland A E (2011) What prevents people with chronic obstructive pulmonary disease from attending pulmonary rehabilitation? A systematic review, <i>Chronic Respiratory Disease</i> 8 (2) : 89-99</p>	<p>The aim of this review was to determine the factors associated with uptake and completion of pulmonary rehabilitation for people with COPD.</p> <p>Travel and transport were consistently identified as barriers to both uptake and completion. A lack of perceived benefit of pulmonary rehabilitation also influenced both uptake and completion. The only demographic features that consistently predicted non-completion were being a current smoker (pooled odds ratio 0.17, 95% confidence interval 0.10 to 0.32) and depression. The limited data available regarding barriers to uptake indicated that disruption to usual routine, influence of the referring doctor and program timing were important.</p> <p>Conclusion: poor access to transport and lack of perceived benefit affect uptake of pulmonary rehabilitation. Current smokers and patients who are depressed are at increased risk of non-completion. Enhancing attendance in pulmonary rehabilitation will require more attention to transportation, support for those at risk of non-completion and greater involvement of patients in informed decisions about their care.</p>
<p>Lacasse Y, Goldstein R, Lasserson T J and Martin S (2006) Pulmonary rehabilitation for chronic obstructive pulmonary, <i>Cochrane</i></p>	<p>To determine the impact of rehabilitation on health-related quality of life (QoL) and exercise capacity in patients with COPD.</p> <p>A total of 31 randomized controlled trials (RCTs) met the inclusion criteria. Statistically significant improvements were found for all the outcomes. In four important domains of QoL (Chronic Respiratory Questionnaire scores for Dyspnoea, Fatigue, Emotional function and Mastery), the effect was larger than the minimal clinically important difference of 0.5 units (for example: Dyspnoea score: WMD 1.0 units; 95% confidence interval: 0.8 to 1.3 units; n = 12 trials). Statistically significant improvements were noted in two of the three domains of the St. Georges Respiratory Questionnaire. For FEC and MEC, the effect was small and slightly below the threshold of clinical significance for the six-minute walking distance (WMD: 48 metres; 95% CI: 32 to 65; n = 16 trials).</p>



<p>Lacasse Y, Wong E, Guyatta G H, King D, Cook D J and Goldstein R S (1996) Meta-analysis of respiratory rehabilitation in chronic obstructive pulmonary disease, <i>The Lancet</i> 348 (9035) : 1115-1119</p>	<p>A meta-analysis of randomised controlled trials of respiratory rehabilitation in patients with COPD that assessed functional or maximal exercise capacity, HRQL, or both. Respiratory rehabilitation was defined as exercise training (for at least 4 weeks) with or without education, psychological support, or both. The most commonly used measure for HRQL was the chronic respiratory questionnaire, in which responses were presented on a 7-point scale. The control groups received no rehabilitation.</p> <p>14 trials were included. Significant improvements were found for all the outcomes. For two important features of HRQL, dyspnoea and mastery, the overall treatment effect was larger than the MCID: 1.0 (95% CI 0.6–1.5) and 0.8 (0.5–1.2), respectively, compared with an MCID of 0.5. For functional exercise capacity (6-min walk test), the overall effect was 55.7 m (27.8–92.8), and for maximum exercise capacity (incremental cycle ergometer test), 8.3 W (2.8–16.5). Functional exercise capacity showed heterogeneity that could not be explained by the sensitivity analyses.</p> <p>Summary: Respiratory rehabilitation relieves dyspnoea and improves control over COPD. These improvements are clinically important. The value of the improvement in exercise capacity is not clear. Respiratory rehabilitation is an effective part of care in patients with COPD..</p>
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c) Education

Study	Methods	Findings
<p>Blackstock F C, Webster K E, McDonald C F and Hill C J (2014) Comparable improvements achieved in chronic obstructive pulmonary disease through pulmonary rehabilitation with and without a structured educational intervention: A randomized controlled trial, <i>Respirology</i> 19 (2) : 193-202</p>	<p>This trial sought to determine whether the addition of education to exercise training resulted in greater improvements in health outcomes than pulmonary rehabilitation where education has been omitted. A randomized trial with allocation concealment, assessor blinded to group allocation and intention-to-treat analysis was conducted. Two hundred and sixty-seven people with COPD (mean age 72(9) years, forced expiratory volume in 1?s, 59(23)% predicted) were allocated to receive either 8 weeks of twice weekly group exercise training plus education or exercise training alone. Education was disease specific with a self-management focus. Primary outcome measures included 6-min walk distance and Chronic Respiratory Questionnaire. Secondary outcomes included dyspnoea, health behaviours, generic health-related quality of life, self-efficacy and healthcare usage with measurements taken immediately following completion and at 6 and 12 months.</p>	<p>There were no significant differences that indicated greater improvement in any health outcome with the addition of education. The two intervention groups had similar significant improvements immediately following intervention, and these were maintained comparably in the subsequent 12 months.</p> <p>Conclusions:</p> <p>The results of this investigation suggest that disease-specific group education is not an essential component of pulmonary rehabilitation. Pulmonary rehabilitation based on exercise training is an effective option in the management of patients with COPD if multidisciplinary education cannot be offered.</p>

<p>Gillespie P, O'Shea E, Casey D, Murphy K, Devane D, Cooney A, Mee L, Kirwan C, McCarthy B and Newell J for the PRINCE study team (2013) The cost-effectiveness of a structured education pulmonary rehabilitation programme for chronic obstructive pulmonary disease in primary care: the PRINCE cluster randomised trial, <i>BMJ Open</i> 3 (11)</p>	<p>To assess the effectiveness and cost-effectiveness of a structured education pulmonary rehabilitation programme (SEPRP) for chronic obstructive pulmonary disease (COPD) relative to usual practice in primary care. The programme consisted of group-based sessions delivered jointly by practice nurses and physiotherapists over 8 weeks.</p>	<p>Participants allocated to the intervention group had statistically significant higher mean change total CRQ scores (adjusted mean difference (MD) 1.11, 95% CI 0.35 to 1.87). Participants allocated to the intervention group also had statistically significant higher mean CRQ Dyspnoea scores after intervention (adjusted MD 0.49, 95% CI 0.20 to 0.78) and CRQ Physical scores (adjusted MD 0.37, 95% CI 0.14 to 0.60).</p>
<p>Casey D, Murphy K, Devane D, Cooney A, McCarthy B, Mee L, Newell J, O'Shea E, Scarrott C, Gillespie P, Kirwan C and Murphy A W (2013) The effectiveness of a structured education pulmonary rehabilitation programme for improving the health status of people with moderate and severe chronic obstructive pulmonary disease in primary care: the PRINCE cluster randomised trial, <i>Thorax</i> 68 (10)</p>	<p>Setting: 32 general practices in Ireland.          Participants: 350 adults with COPD, 69% of whom were moderately affected.          Interventions: Intervention arm (n=178) received a 2 h group-based SEPRP session per week over 8 weeks delivered jointly by a practice nurse and physiotherapist at the practice surgery or nearby venue. The control arm (n=172) received the usual practice in primary care.          Main outcome measures: Incremental costs, Chronic Respiratory Questionnaire (CRQ) scores, quality-adjusted life years (QALYs) gained estimated using the generic EQ5D instrument, and expected cost-effectiveness at 22 weeks trial follow-up.</p>	<p>The intervention was associated with an increase of €944 (95% CIs 489 to 1400) in mean healthcare cost and €261 (95% CIs 226 to 296) in mean patient cost. The intervention was associated with a mean improvement of 1.11 (95% CIs 0.35 to 1.87) in CRQ Total score and 0.002 (95% CIs -0.006 to 0.011) in QALYs gained. These translated into incremental cost-effectiveness ratios of €850 per unit increase in CRQ Total score and €472 per additional QALY gained. The probability of the intervention being cost-effective at respective threshold values of €5000, €15 000, €25 000, €35 000 and €45 000 was 0.980, 0.992, 0.994, 0.994 and 0.994 in the CRQ Total score analysis compared to 0.000, 0.001, 0.001, 0.003 and 0.007 in the QALYs gained analysis.</p>
<p>Murphy K, Casey D, Devane D, Cooney A, McCarthy B, Mee L, Newell John, O'Shea E, Kirwan C and Murphy A W (2011) The effectiveness of a structured education pulmonary rehabilitation programme for improving the health status of people with chronic obstructive pulmonary disease (COPD): The PRINCE Study., <i>Irish Journal of Medical Science</i> 180 (Supp 12) : S457</p>	<p>(This cell content is merged with the middle cell above)</p>	<p>While analysis suggests that SEPRP was cost-effective if society is willing to pay at least €850 per one-point increase in disease-specific CRQ, no evidence exists when effectiveness was measured in QALYs gained.</p>

<p>Ries A L, Kaplan R M, Limberg T M and Prewitt L M (1995) Effects of Pulmonary Rehabilitation on Physiologic and Psychosocial Outcomes in Patients with Chronic Obstructive Pulmonary Disease, <i>Annals of Internal Medicine</i> 122 (11) : 823-832</p>	<p>To compare the effects of comprehensive pulmonary rehabilitation with those of education alone on physiologic and psychosocial outcomes in patients with chronic obstructive pulmonary disease.</p> <p>119 outpatients with chronic obstructive pulmonary disease were randomly assigned to either an 8-week comprehensive pulmonary rehabilitation program or to an 8-week education program. Pulmonary rehabilitation consisted of twelve 4-hour sessions that included education, physical and respiratory care instruction, psychosocial support, and supervised exercise training. Monthly reinforcement sessions were held for 1 year. The education group attended four 2-hour sessions that included videotapes, lectures, and discussions but not individual instruction or exercise training.</p> <p>Measurements: Pulmonary function, maximum exercise tolerance and endurance, gas exchange, symptoms of perceived breathlessness and muscle fatigue with exercise, shortness of breath, self-efficacy for walking, depression, general quality of well-being, and hospitalizations associated with pulmonary diseases. Patients were followed for 6 years.</p>	<p>Compared with education alone, comprehensive pulmonary rehabilitation produced a significantly greater increase in maximal exercise tolerance (+1.5 metabolic equivalents [METS] compared with +0.6 METS (P &lt; 0.001); maximal oxygen uptake, +0.11 L/min compared with +0.03 L/min [P = 0.06]), exercise endurance (+10.5 minutes compared with +1.3 minutes [P &lt; 0.001]), symptoms of perceived breathlessness (score of -1.5 compared with +0.2 [P &lt; 0.001]) and muscle fatigue (score of -1.4 compared with -0.2[P &lt; 0.01]), shortness of breath (score of -7.0 compared with +0.6 [P&lt;0.01]), and self-efficacy for walking (score of +1.4 compared with +0.1 [P &lt; 0.05]). There were slight but non-significant differences in survival (67% compared with 56% [P = 0.32]) and duration of hospital stay (-2.4 days/patient per year compared with +1.3 days/patient per year [P = 0.20]). Measures of lung function, depression, and general quality of life did not differ between groups. Differences tended to diminish after 1 year of follow-up.</p> <p>Conclusions: Comprehensive pulmonary rehabilitation significantly improved exercise performance and symptoms for patients with moderate to severe chronic obstructive pulmonary disease. Benefits were partially maintained for at least 1 year and tended to diminish after that time.</p>
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## d) Nutrition

Study	Methods	Findings
<p>van Wetering C R, Hoogendoorn M, Broekhuizen R, Geraerts-Keerisd G J W, De Munck D R A J, Rutten-van Mólken M P M H and Schols A M W J (2010) Efficacy and Costs of Nutritional Rehabilitation in Muscle-Wasted Patients With Chronic Obstructive Pulmonary Disease in a Community-Based Setting: A Prespecified Subgroup Analysis of the INTERCOM Trial, <i>Journal of the American Medical Directors Association</i> 11 (3) : 179-187</p>	<p>In a 2-year RCT, 199 COPD patients (FEV1%pred. 60% [SD 16%]) and impaired exercise capacity were randomized to the interdisciplinary community-based COPD management program (INTERCOM) or usual care (UC). A prescheduled subgroup analysis was performed on 39 of 199 patients who were muscle wasted and received UC or nutritional therapy in combination with exercise training. Body composition, muscle strength, and exercise capacity were assessed at baseline and 4, 12, and 24 months.</p>	<p>Between group differences after 4 months in favour of the intervention group: fat free mass index (FFMI 0.9 kg/m<sup>2</sup> [SE = 0.2, P &lt; .001]), body mass index (BMI 1.0 kg/m<sup>2</sup> [SE = 0.4, P = .009]), maximum inspiratory mouth pressure (Pimax 1.4 kPa [SE = 0.5, P = .011]), quadriceps average power (QAP 13.1 Watt [SE=5.8, P = .036]), 6-minute walking distance (6MWD 27 m, [SE = 11.5, P = .028]), cycle endurance time (CET 525 seconds [SE=195, P = .013]), and peak exercise capacity (Wmax 12 Watt [SE = 5, P = .036]).</p> <p>Between group difference over 24 months in favour of the intervention group: Pimax 1.7 kPa (SE = 0.53, P = .004), QAP 19 Watt (SE = 6, P = .005), 6MWD 57 (SE = 19, P = .006), and CET 485 seconds (SE = 159, P = .006).</p> <p>After 4 months total costs were Euro 1501 higher in the intervention group than in the UC group (P &lt; .05), but not significantly different after 24 months. Hospital admission costs were significantly lower in the intervention group –€ 4724 (95% CI –7704, –1734).</p> <p>Conclusion: Muscle-wasted COPD patients with moderate airflow obstruction show a prolonged positive response to nutritional support integrated in a community-based rehabilitation program.</p>

## e) Comparative – four weeks / seven weeks, early / late

Study	Methods	Findings
<p>Puhan M A, Spaar A, Frey M, Turk A, Brändli O, Ritscher D, Achermann E, Kaelin R and Karrer W (2012) Early versus Late Pulmonary Rehabilitation in Chronic Obstructive Pulmonary Disease Patients with Acute Exacerbations: A Randomized Trial, <i>Respiration</i> 83 : 499-506</p>	<p>To compare the effects of early and late pulmonary rehabilitation on exacerbation rates and health-related quality of life (HRQOL) in COPD patients with exacerbations.</p> <p>Methods: COPD patients (Global Initiative for Chronic Obstructive Lung Disease stages II–IV) with a recent exacerbation were randomised to early (within 2 weeks) or late pulmonary rehabilitation (starting 6 months after randomization and in a stable state). The primary outcome was the exacerbation rate over 18 months, and secondary outcomes included HRQOL and mortality.</p>	<p>On average, patients with early rehabilitation (n = 19) had 2.61 (SD 2.96) exacerbations requiring systemic corticosteroids and/or antibiotics, compared to 2.77 (SD 3.41) in patients with late rehabilitation (adjusted incidence rate ratio 0.83, 95% confidence interval 0.43–1.63; p = 0.60). Over the 18-month period, patients with late rehabilitation experienced more dyspnoea (difference on Chronic Respiratory Questionnaire dyspnoea domain 0.74 and on the Medical Research Council dyspnoea scale 0.37), but neither these differences nor any difference in HRQOL domains reached statistical significance. Conclusions: The study did not find any statistically significant differences between early and late pulmonary rehabilitation. However, the trial indicates that early rehabilitation may lead to faster recovery of HRQOL after exacerbations compared to rehabilitation later on when patients are in a stable state.</p>

<p>Green R H, Singh S J, Williams J and Morgan M D L (2001) A randomised controlled trial of four weeks versus seven weeks of pulmonary rehabilitation in chronic obstructive pulmonary disease, <i>Thorax</i> 56 (2) : 143-145</p>	<p>To assess whether the current pulmonary rehabilitation programme could be shortened a randomised controlled trial was conducted in 44 patients with COPD who were allocated to either a seven week or a four week course. They were assessed at baseline and at completion by the Chronic Respiratory Questionnaire (CRQ), the Breathing Problems Questionnaire (BPQ), the incremental shuttle walking test (SWT), and the treadmill endurance test (TET)</p>	<p>Patients who completed the seven week rehabilitation programme had greater improvements in all outcome measures than those undertaking the four week course. These differences reached clinical and statistical significance for the total CRQ score, which was the primary outcome variable (mean difference (95% confidence intervals (CI) of difference) – 0.61(–0.15 to –1.08), <math>p&lt;0.05</math>), and the CRQ domains of dyspnoea (–0.80 (95% CI –0.13 to –1.48), <math>p&lt;0.05</math>), emotion (–0.89 (95% CI –0.33 to –1.45), <math>p&lt;0.005</math>), and mastery (–0.84 (95% CI –0.10 to –1.58), <math>p&lt;0.05</math>). There were also trends towards greater improvements in exercise assessments in the seven week group but the differences did not reach statistical significance (SWT: mean difference –16.9 (95% CI 24.8 to –58.6), <math>p=0.41</math>; TET: geometric mean difference –1.21 (95% CI –0.60 to –2.47), <math>p=0.56</math>).</p> <p>Conclusions: A seven week course of pulmonary rehabilitation provides greater benefits to patients than a four week course in terms of improvements in health status.</p>
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## f) Alternative therapies – Tai Chi and Acupuncture

Study	Methods	Findings
<p>Ng L, Chiang L K, Tang R, Siu C, Fung L, Lee A and Tam W (2014) Effectiveness of incorporating Tai Chi in a pulmonary rehabilitation program for Chronic Obstructive Pulmonary Disease (COPD) in primary care—A pilot randomized controlled trial, <i>European Journal of Integrative Medicine</i></p>	<p>The aim of this single-blind randomized controlled study was to compare the self-efficacy and quality of life parameters of COPD patients who underwent pulmonary rehabilitation with or without Tai Chi elements incorporated in the exercise component.</p> <p>Methods: 192 COPD patients, recruited from four primary care clinics, satisfied the eligibility criteria and consented to randomization to either pulmonary rehabilitation program group (PRP) or the group with Tai Chi elements added to PRP (TC). Both groups received rehabilitation consisting of 2 sessions per week for 6 weeks with totally identical content except that Tai Chi exercises were added to TC group. Data collection was performed at baseline, 2 and 6-month post-intervention.</p>	<p>Intention-to-treat analysis was performed for 192 subjects. Both groups did not differ in demographics and baseline variables except for COPD staging, mean FEV1, FEV1%-Pred, Saint George Respiratory Questionnaire SGRQ activity score and COPD-CSES self-efficacy score. Statistical improvements were seen in exercise capacity, health status and self-efficacy within both groups at 6-month post-intervention. Although more favourable improvements in physiological outcomes and health status were demonstrated in Tai Chi group, only the functional exercise capacity showed statistical improvement between groups at 6 months post-intervention (<math>\beta = 12.786</math> m; 95% CI = 3.794, 21.777; <math>p = 0.006</math>).</p> <p>Conclusion: The adjuvant effect of incorporating Tai Chi in pulmonary rehabilitation showed a modest complementary benefit in exercise capacity.</p>



<p>Suzuki M, Muro S, Ando Y, Omori T, Shiota T, Endo K, Sato S, Aihara K, Matsumoto M, Suzuki S, Itotani R, Ishitoko M, Hara Y, Takemura M, Ueda T, Kagioka H, Hirabayashi M, Fukui M and Mishima M (2012) A Randomized, Placebo-Controlled Trial of Acupuncture in Patients With Chronic Obstructive Pulmonary Disease (COPD): The COPD-Acupuncture Trial (CAT), <i>JAMA Internal Medicine (formerly Archives of Internal Medicine)</i> 172 (11) : 878-886</p>	<p>This study was performed to determine whether acupuncture is superior to placebo needling in improving DOE in patients with COPD who are receiving standard medication.</p> <p>Methods: Sixty-eight of 111 patients from the Kansai region of Japan who were diagnosed as having COPD and were receiving standard medication participated in a randomized, parallel-group, placebo-controlled trial (July 1, 2006, through March 31, 2009) in which the patients, evaluators, and statistician were unaware of the random allocation. Participants were randomly assigned to traditional acupuncture (real acupuncture group, n = 34) or placebo needling (placebo acupuncture group, n = 34). Both groups received real or placebo needling at the same acupoints once a week for 12 weeks. The primary end point was the modified Borg scale score evaluated immediately after the 6-minute walk test. Measurements were obtained at baseline and after 12 weeks of treatment.</p>	<p>Result After 12 weeks: the Borg scale score after the 6-minute walk test was significantly better in the real acupuncture group compared with the placebo acupuncture group (mean [SD] difference from baseline by analysis of covariance, -3.6 [1.9] vs 0.4 [1.2]; mean difference between groups by analysis of covariance, -3.58; 95% CI, -4.27 to -2.90). Patients with COPD who received real acupuncture also experienced improvement in the 6-minute walk distance during exercise, indicating better exercise tolerance and reduced DOE.</p> <p>Conclusion: This study demonstrates that acupuncture is a useful adjunctive therapy in reducing Dyspnoea on exertion (DOE) in patients with COPD.</p>
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## g) Other issues

Study	Methods	Findings
<p>Ali M S, Talwar D and Jain S K (2014) The Effect of a Short-Term Pulmonary Rehabilitation on Exercise Capacity and Quality of Life in Patients Hospitalised with Acute Exacerbation of Chronic Obstructive Pulmonary Disease, <i>The Indian Journal of Chest Diseases &amp; Allied Sciences</i> 56 : 13-19</p>	<p>To evaluate the utility of a 3-week pulmonary rehabilitation (PR) programme in patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD). Patients admitted with AECOPD, following clinical stabilisation in the respiratory intensive care unit (RICU), were alternately assigned to intervention (n=15); and control groups (n=15), respectively. The intervention group patients were treated with usual care plus PR exercises in the form of 20 minutes each of walking, bicycle ergometry and resistance exercises, thrice-weekly for three weeks. The control group patients were treated with only the usual care. After discharge from hospital the treatment regimens were continued on alternate days on outpatient basis, for a total of three weeks.</p>	<p>Nine sessions of PR exercises produced statistically significant improvement in general well-being, forced expiratory volume in the first second (FEV1), 6MWT parameters, exercise capacity, peak oxygen uptake and volume of oxygen consumption (VO2)/Watts slope on CPET in patients with AECOPD.</p> <p>Conclusion: Short duration PR programmes appear to be helpful in the management of AECOPD.</p>

<p>Ramos E M C, de Toledo-Arruda A C, Fosco L C, Bonfim R, Bertolini G N, Guarnier F A, Cecchini R, Pastre C M, Langer D, Gosselink R and Ramos D (2014) The effects of elastic tubing-based resistance training compared with conventional resistance training in patients with moderate chronic obstructive pulmonary disease: a randomized clinical trial, <i>Clinical Rehabilitation</i>: March 2014</p>	<p>To investigate the effects of elastic tubing training compared with conventional resistance training on the improvement of functional exercise capacity, muscle strength, fat-free mass, and systemic inflammation in patients with chronic obstructive pulmonary disease.</p> <p>Forty nine patients with moderate chronic obstructive pulmonary disease were randomly assigned to perform elastic tubing training or conventional resistance training three times per week for eight weeks.</p> <p>The primary outcome measure was functional exercise capacity. The secondary outcome measures were peripheral muscle strength, health-related quality of life assessed by the Chronic Respiratory Disease Questionnaire (CRDQ), fat-free mass, and cytokine profile.</p>	<p>After eight weeks, the mean distance covered during six minutes increased by 73 metres (<math>\pm 69</math>) in the elastic tubing group and by 42 metres (<math>\pm 59</math>) in the conventional group (<math>p &lt; 0.05</math>). The muscle strength and quality of life improved in both groups (<math>P &lt; 0.05</math>), with no significant differences between the groups. There was a trend toward an improved fat-free mass in both groups (<math>P = 0.05</math>). After the first and last sessions, there was an increase in interleukin 1<math>\beta</math> (IL-1<math>\beta</math>) and interleukin 10 (IL-10) in both groups, while tumour necrosis factor alpha (TNF-<math>\alpha</math>) was stimulated only in the conventional training group.</p> <p>Conclusion: Elastic tubing training had a greater effect on functional exercise capacity than conventional resistance training. Both interventions were equally effective in improving muscle strength and quality of life.</p>
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<p>McNamara R J, McKeough Z J, McKenzie D K and Alison J A (2013) Water-based exercise in COPD with physical comorbidities: a randomised controlled trial, <i>European Respiratory Journal</i> 41 (6) : 1284-1291</p>	<p>This randomised controlled trial aimed to determine the effectiveness of water-based exercise training in improving exercise capacity and quality of life compared to land-based exercise training and control (no exercise) in people with COPD and physical co-morbidities. Participants referred to pulmonary rehabilitation were randomly allocated to a water-based exercise, land-based exercise or the control group. The two exercise groups trained for 8 weeks, completing three sessions per week. Forty five out of 53 participants (mean±sd age 72±9 years; completed the study.</p>	<p>Compared to controls, water-based exercise training significantly increased 6-min walking distance, incremental and endurance shuttle walk distances, and improved Chronic Respiratory Disease Questionnaire (CRDQ) dyspnoea and fatigue. Compared to land-based exercise training, water-based exercise training significantly increased incremental shuttle walk distance (mean difference 39 m, 95% CI 5–72 m), endurance shuttle walk distance (mean difference 228 m, 95% CI 19–438 m) and improved CRDQ fatigue.</p> <p>Water-based exercise training was significantly more effective than land-based exercise training and control in increasing peak and endurance exercise capacity and improving aspects of quality of life in people with COPD and physical co-morbidities.</p>
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<p>Revitt O, Sewell L, Morgan M D L, Steiner M and Singh S (2013) Short outpatient pulmonary rehabilitation programme reduces readmission following a hospitalization for an exacerbation of chronic obstructive pulmonary disease, <i>Respirology</i> 18 (7) : 1063-1068</p>	<p>This study aimed to explore the effectiveness of a short outpatient PR programme and the impact upon readmission rates.</p> <p>One hundred sixty (87 males) patients, mean (SD) age 70.35 (8.59) years, forced expiratory volume in 1 s 0.99 (0.44) litres were assessed for a 7-week PR programme following a hospital admission for an acute exacerbation of COPD. Patients were assessed and commenced PR within 4 weeks of discharge from hospital. Outcome measures included: Incremental Shuttle Walking Test (ISWT), Endurance Shuttle Walk Test (ESWT), Chronic Respiratory Questionnaire Self-Reported (CRQ-SR). Patients were assessed at baseline and at 7 weeks (after the 4-week supervised and 3-week unsupervised components). Readmission data were collected retrospectively for the 12 months pre and post admission (n=155).</p>	<p>Statistically significant improvements were found in the ISWT, ESWT and CRQ-SR at discharge (P&lt;0.05). The number of admission was significantly less in the 12-month post-pulmonary rehabilitation compared to the previous 12 months.</p> <p>Conclusions: A short course of PR showed improvements in exercise capacity and health status in patients who have had an acute exacerbation of COPD. The number of readmissions was also significantly lower in the year following PR.</p>
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<p>Yamaguti W P, Claudino R C, Neto A P, Chammas M C, Gomes A C, Salge J M, Moriya H T, Cukier A and Carvalho C R (2012) Diaphragmatic Breathing Training Program Improves Abdominal Motion During Natural Breathing in Patients With Chronic Obstructive Pulmonary Disease: A Randomized Controlled Trial, <i>Archives of Physical Medicine and Rehabilitation</i> 93 (4) : 571-577</p>	<p>To investigate the effects of a diaphragmatic breathing training program (DBTP) on thoracoabdominal motion and functional capacity in patients with chronic obstructive pulmonary disease.</p> <p>Subjects (N=30; forced expiratory volume in 1s, 42%±13% predicted) were randomly allocated to either a training group (TG) or a control group (CG). Subjects in the TG completed a 4-week supervised DBTP (3 individualized weekly sessions), while those in the CG received their usual care.</p> <p>Effectiveness was assessed by amplitude of the rib cage to abdominal motion ratio (RC/ABD ratio) (primary outcome) and diaphragmatic mobility (secondary outcome). The RC/ABD ratio was measured using respiratory inductive plethysmography during voluntary diaphragmatic breathing and natural breathing. Diaphragmatic mobility was measured by ultrasonography. A 6-minute walk test and health-related quality of life were also evaluated.</p>	<p>Immediately after the 4-week DBTP, the TG showed a greater abdominal motion during natural breathing quantified by a reduction in the RC/ABD ratio when compared with the CG (F=8.66; P&lt;.001). Abdominal motion during voluntary diaphragmatic breathing after the intervention was also greater in the TG than in the CG (F=4.11; P&lt;.05). The TG showed greater diaphragmatic mobility after the 4-week DBTP than did the CG (F=15.08; P&lt;.001). An improvement in the 6-minute walk test and in health-related quality of life was also observed in the TG.</p> <p>Conclusions:</p> <p>DBTP for patients with chronic obstructive pulmonary disease induced increased diaphragm participation during natural breathing, resulting in an improvement in functional capacity.</p>
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<p>Taylor S J C, Sohanpal R, Bremner S A, Devine A, McDaid D, Fernández J-L, Griffith C J and Eldridge S (2012) Self-management support for moderate-to-severe chronic obstructive pulmonary disease: a pilot randomised controlled trial, <i>British Journal of General Practice</i> 62 (603) : e687-e695</p>	<p>A pilot randomised controlled trial in one UK primary care trust area to explore the feasibility, effectiveness and cost effectiveness of a novel, layperson-led, theoretically driven COPD self-management support programme.</p> <p>Patients with moderate to severe COPD were identified through primary care and randomised 2:1 to the 7-week-long, group intervention or usual care. Outcomes at baseline, 2, and 6 months included self-reported health, St George's Respiratory Questionnaire (SGRQ), EuroQol, and exercise.</p> <p>Forty-four per cent responded to GP invitation, 116 were randomised: mean (standard deviation [SD]) age 69.5 (9.8) years, 46% male, 78% had unscheduled COPD care in the previous year.</p> <p>Forty per cent of intervention patients completed the course; 35% attended no sessions; and 78% participants completed the 6-month follow-up questionnaire.</p>	<p>Results suggest that the intervention may increase both QoL (mean EQ-5D change 0.12 (95% confidence interval [CI] = -0.02 to 0.26) higher, intervention versus control) and exercise levels, but not SGRQ score. Economic analyses suggested that with thresholds of £20 000 per quality-adjusted life-year gained, the intervention is likely to be cost-effective.</p> <p>Conclusion: This intervention has good potential to meet the UK National Institute for Health and Clinical Excellence criteria for cost effectiveness. However, to make a substantial impact on COPD self-management, it will also be necessary to explore other ways to enable patients to access self-management education.</p>
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<p>Duiverman M L, Wempe J B, Bladder G, Vonk J M, Zijlstra J G, Kerstjens H A M and Wijkstra P J (2011) Two-year home-based nocturnal noninvasive ventilation added to rehabilitation in chronic obstructive pulmonary disease patients: A randomized controlled trial, <i>Respiratory Research</i> 12 : 112</p>	<p>To compare the outcome of 2-year home-based nocturnal non-invasive intermittent positive pressure ventilation (NIPPV) in addition to rehabilitation (NIPPV + PR) with rehabilitation alone (PR) in COPD patients with chronic hypercapnic respiratory failure.</p> <p>Sixty-six patients were analyzed for the two-year home-based follow-up period. The primary outcome was health-related quality of life (HRQoL); secondary outcomes were mood state, dyspnoea, gas exchange, functional status, pulmonary function, and exacerbation frequency.</p>	<p>Although the addition of NIPPV did not significantly improve the Chronic Respiratory Questionnaire compared to rehabilitation alone (mean difference in change between groups -1.3 points (95% CI: -9.7 to 7.4)), the addition of NIPPV did improve HRQoL assessed with the Mageri Respiratory Failure questionnaire (-13.4% (-22.7 to -4.2; p = 0.005)), mood state (Hospital Anxiety and Depression scale -4.0 points (-7.8 to 0.0; p = 0.05)), dyspnoea (Medical Research Council -0.4 points (-0.8 to -0.0; p = 0.05)), daytime arterial blood gases (PaCO<sub>2</sub> -0.4 kPa (-0.8 to -0.2; p = 0.01); PaO<sub>2</sub> 0.8 kPa (0.0 to 1.5; p = 0.03)), 6-minute walking distance (77.3 m (46.4 to 108.0; p &lt; 0.001)), Groningen Activity and Restriction scale (-3.8 points (-7.4 to -0.4; p = 0.03)), and forced expiratory volume in 1 second (115 ml (19 to 211; p = 0.019)). Exacerbation frequency was not changed.</p> <p>Conclusions: The addition of NIPPV to pulmonary rehabilitation for 2 years in severe COPD patients with chronic hypercapnic respiratory failure improves HRQoL, mood, dyspnoea, gas exchange, exercise tolerance and lung function decline. The benefits increase further with time.</p>
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<p>Man W D-C, Polkey M I, Donaldson N, Gray B J and Moxham J (2004) Community pulmonary rehabilitation after hospitalisation for acute exacerbations of chronic obstructive pulmonary disease: randomised controlled study, <i>BMJ</i> 329 (7476) : 1209</p>	<p>To evaluate the effects of an early community based pulmonary rehabilitation programme after hospitalisation for acute exacerbations of chronic obstructive pulmonary disease (COPD).</p> <p>A randomised control trial of 42 inner London hospital patients admitted with an acute exacerbation of COPD with an eight week, pulmonary rehabilitation programme for outpatients, started within 10 days of hospital discharge, or usual care.</p> <p>Main outcome measures: Incremental shuttle walk distance, disease specific health status (St George's respiratory questionnaire, SGRQ; chronic respiratory questionnaire, CRQ) and generic health status (medical outcomes short form 36 questionnaire, SF-36) at three months after hospital discharge.</p>	<p>Early pulmonary rehabilitation, compared with usual care, led to significant improvements in median incremental shuttle walk distance (60 metres, 95% confidence interval 26.6 metres to 93.4 metres, <math>P = 0.0002</math>), mean SGRQ total score (-12.7, -5.0 to -20.3, <math>P = 0.002</math>), all four domains of the CRQ (dyspnoea 5.5, 2.0 to 9.0, <math>P = 0.003</math>; fatigue 5.3, 1.9 to 8.8, <math>P = 0.004</math>; emotion 8.7, 2.4 to 15.0, <math>P = 0.008</math>; and mastery 7.5, 4.2 to 10.7, <math>P &lt; 0.001</math>) and the mental component score of the SF-36 (20.1, 3.3 to 36.8, <math>P = 0.02</math>). Improvements in the physical component score of the SF-36 did not reach significance (10.6, -0.3 to 21.6, <math>P = 0.057</math>).</p> <p>Conclusion: Early pulmonary rehabilitation after admission to hospital for acute exacerbations of COPD is safe and leads to statistically and clinically significant improvements in exercise capacity and health status at three months.</p>
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<p>Griffiths T L, Burr M L, Campbell I A, Lewis-Jenkins V, Mullins J, Shiels K, Turner-Lawlor P J, Payne N, Newcombe R G, Lonescu A A, Thomas J and Tunbridge J (2000) Results at 1 year of outpatient multidisciplinary pulmonary rehabilitation: a randomised controlled trial, <i>The Lancet</i> 355 (9201) : 362-368</p>	<p>A randomised controlled trial to assess the effect of outpatient pulmonary rehabilitation on use of health care and patients' wellbeing over 1 year. Methods: 200 patients with disabling chronic lung disease (the majority with chronic obstructive pulmonary disease) were randomly assigned a 6-week multidisciplinary rehabilitation programme (18 visits) or standard medical management. Use of health services was assessed from hospital and general-practice records. Analysis was by intention to treat.</p>	<p>There was no difference between the rehabilitation (n=99) and control (n=101) groups in the number of patients admitted to hospital (40 vs 41) but the number of days these patients spent in hospital differed significantly (mean 10.4 [SD 9.7] vs 21.0 [20.7], p=0.022). The rehabilitation group had more primary-care consultations at the general practitioner's premises than did the control group (8.6 [6.8] vs 7.3 [8.3], p=0.033) but fewer primary-care home visits (1.5 [2.8] vs 2.8 [4.6], p=0.037). Compared with control, the rehabilitation group also showed greater improvements in walking ability and in general and disease-specific health status.</p> <p>Summary: For patients chronically disabled by obstructive pulmonary disease, an intensive, multidisciplinary, outpatient programme of rehabilitation is an effective intervention, in the short term and the long term, that decreases use of health services.</p>
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<p>Troosters T, Gosselink R and Decramer M (2000) Short- and long-term effects of outpatient rehabilitation in patients with chronic obstructive pulmonary disease: a randomized trial, <i>The American Journal of Medicine</i> 109 (3) : 207-212</p>	<p>To investigated the short- and long-term effects of a 6-month outpatient rehabilitation program in patients with severe COPD, one hundred patients were randomly assigned to receive either an exercise training program that included cycling, walking, and strength training (n = 50) or usual medical care (n = 50).</p> <p>Thirty-four patients in the training group were evaluated after 6 months (end of training), and 26 were evaluated after 18 months of follow-up. In the control group, 28 patients were evaluated at 6 months and 23 after 18 months.</p> <p>Measures: pulmonary function, 6-minute walking distance, maximal exercise capacity, peripheral and respiratory muscle strength, and quality of life (on a 20 to 140–point scale), and estimated cost-effectiveness of the program.</p>	<p>At 6 months, the training group showed improvement in 6-minute walking distance [mean difference (training - control) of 52 m; 95% confidence interval (CI), 15 to 89 m], maximal work load (12 W; 95% CI, 6 to 19 W), maximal oxygen uptake (0.26 liters/min; 95% CI, 0.07 to 0.45 liters/min), quadriceps force (18 Nm; 95% CI, 7 to 29 Nm), inspiratory muscle force (11 cm H<sub>2</sub>O; 95% CI, 3 to 20 cm H<sub>2</sub>O), and quality of life (14 points; 95% CI, 6 to 21 points; all P &lt;0.05). At 18 months all these differences persisted (P &lt;0.05), except for inspiratory muscle strength. For 6-minute walking distance and quality of life, the differences between the training group and controls at 18 months exceeded the minimal clinically-important difference.</p> <p>Conclusion: Among patients who completed the 6-month program, outpatient training resulted in significant and clinically relevant changes in 6-minute walking distance, maximal exercise performance, peripheral and respiratory muscle strength, and quality of life. Most of these effects persisted 18 months after starting the program.</p>
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<p>Criner G J, Cordova F C, Furukawa S, Kuzma A M, Travaline J M, Leyenson V, and O'Brien G M (1999) Prospective Randomized Trial Comparing Bilateral Lung Volume Reduction Surgery to Pulmonary Rehabilitation in Severe Chronic Obstructive Pulmonary Disease, <i>American Journal of Respiratory and Critical Care Medicine</i> 160 (6) : 2018-2027</p>	<p>Two hundred patients with severe chronic obstructive pulmonary disease (COPD) were recruited for a prospective randomized trial of pulmonary rehabilitation versus bilateral lung volume reduction surgery (LVRS) with stapling resection of 20 to 40% of each lung. Pulmonary function tests, gas exchange, 6-min walk distance, and symptom-limited maximal exercise testing were done in all patients at baseline and after 8 wk of rehabilitation. Patients were then randomized to either 3 additional months of rehabilitation or LVRS. Thirty-seven patients met study criteria and were enrolled into the trial. Eighteen patients were in the medical arm; 15 of 18 patients completed 3 mo of additional pulmonary rehabilitation. Thirty-two patients underwent LVRS (19 in the surgical arm, 13 cross-over from the medical arm).</p>	<p>After 8 wk of pulmonary rehabilitation, pulmonary function tests remained unchanged compared with baseline data. However, there was a trend toward a higher 6-min walk distance (<math>285 \pm 96</math> versus <math>269 \pm 91</math> m, <math>p = 0.14</math>) and total exercise time on maximal exercise test was significantly longer compared with baseline values (<math>7.4 \pm 2.1</math> versus <math>5.8 \pm 1.7</math> min, <math>p &lt; 0.001</math>). In 15 patients who completed 3 mo of additional rehabilitation, there was a trend to a higher maximal oxygen consumption. The Sickness Impact Profile (SIP), a generalized measure of quality of life (QOL), was significantly improved after 8 wk of rehabilitation and was maintained after 3 mo of additional rehabilitation. A further improvement in QOL was observed 3 mo after LVRS compared with the initial improvement gained after 8 wk of rehabilitation. Conclusion: Bilateral LVRS, in addition to pulmonary rehabilitation, improves static lung function, gas exchange, and QOL compared with pulmonary rehabilitation alone.</p>
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<p>Wedzicha J A, Bestall J C, Garrod R, Garnham R, Paul E A and Jones P W (1998) Randomized controlled trial of pulmonary rehabilitation in severe chronic obstructive pulmonary disease patients, stratified with the MRC dyspnoea scale, <i>European Respiratory Journal</i> 12 (2) : 363-369</p>	<p>This study tested the hypothesis that severity of respiratory disability may affect the outcome of pulmonary rehabilitation. In this randomized, controlled study, 126 patients with chronic obstructive pulmonary disease (COPD) were stratified for dyspnoea using the Medical Research Council (MRC) dyspnoea score into MRC3/4 (Moderate) (n=66) and MRC 5 (Severe) dyspnoeic (n=60) groups.</p> <p>The patients were randomly assigned to an eight week programme of either exercise plus education (Exercise group) or education (Control group). Education and exercise programmes for the moderately dyspnoeic patients were carried out in a hospital outpatient setting. Severely dyspnoeic patients were all treated at home. Those in the Exercise group received an individualized training programme.</p>	<p>There was a significant improvement in shuttle walking distance in the moderate dyspnoeic group, who received exercise training; baseline (mean+/-SEM) 191+/-22 m, post-rehabilitation 279+/-22 m (p&lt;0.001). There was no improvement in exercise performance in the severely dyspnoeic patients receiving exercise. Neither group of control patients improved. Health status, assessed by the Total Chronic Respiratory Disease Questionnaire score, increased in the moderately dyspnoeic patients receiving exercise from 80+/-18 to 95+/-17 (p&lt;0.0001) after rehabilitation. Much smaller changes were seen in the other three groups. Improvement in exercise performance and health status in patients with chronic obstructive pulmonary disease after an exercise programme depends on the initial degree of dyspnoea.</p>
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