PULMONARY REHABILITATION
Current Evidence and Recommendations
Overview

- Introduction to Pulmonary Rehabilitation
- Pathophysiology of Exercise Limitation
- Exercise training
- Current evidence for COPD
- Current evidence for diseases other than COPD
- Miscellaneous
- Current recommendations
- Take Home message
<table>
<thead>
<tr>
<th>Date</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981 (1974)</td>
<td>Pulmonary rehabilitation is an art of medical practice wherein an individually tailored, multidisciplinary program is formulated, which through accurate diagnosis, therapy, emotional support, and education stabilizes or reverses both the physiology and psychology of pulmonary diseases and attempts to return the patient to the highest possible functional capacity allowed by his pulmonary handicap and overall life situation. Goals are (1) control and alleviate symptoms and complications of respiratory impairment, and (2) teach patients optimal capability to carry out activities of daily life.</td>
</tr>
<tr>
<td>1999</td>
<td>(No definition) The principal goals of pulmonary rehabilitation are to reduce symptoms, decrease disability, increase participation in physical and social activities, and improve the overall quality of life for individuals with chronic respiratory disease.</td>
</tr>
<tr>
<td>2006</td>
<td>Pulmonary rehabilitation is an evidence-based, multidisciplinary, and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decreased daily life activities. Integrated into the individualized treatment of the patients, it is designed to reduce symptoms, optimize functional status, increase participation, and reduce health care costs through stabilizing or reversing systemic manifestations of the disease.</td>
</tr>
<tr>
<td>2013</td>
<td>Pulmonary rehabilitation is a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behavior change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviors.</td>
</tr>
</tbody>
</table>
Comprehensive pulmonary rehabilitation

- Maintenance strategies
- Diagnosis and management of co-morbid conditions
- Nutritional support
- Psychological support and therapy
- Baseline and outcome assessment
- Optimisation of pharmacotherapy
- Exercise prescription
- Interdisciplinary education
- Collaborative chronic disease self-management
Overview

• Introduction to Pulmonary Rehabilitation
• Pathophysiology of Exercise Limitation
• Exercise training
• Current evidence for COPD
• Current evidence for diseases other than COPD
• Current recommendations
• Take Home message
Muscle: Quantity

In COPD, the structure of the quadriceps muscle is altered with a reduction in muscle mass and strength, and is associated with higher mortality and morbidity, in addition to increased hospital admissions.
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Muscle: Quantity

In COPD, the structure of the quadriceps muscle is altered with a reduction in muscle mass and strength and is associated with a higher mortality and morbidity, in addition to increased hospital admissions.


Muscle Quality

- The muscle quality is also impaired; there is preferential reduction in the type I fiber cross-sectional area in the quadriceps muscle in COPD, and reduced oxidative enzyme concentration, mitochondrial density and capillary density.

TERMINATION OF EXERCISE

- Early anaerobic threshold
- Increased ventilatory demand
- Already burned out system

TERMINATION OF EXERCISE
• Lower limb aerobic and strength training are therefore essential components of a pulmonary rehabilitation program.

• Am J Respir Crit Care Med 2013;188(8):e13–64.
Most are partially amenable to rehab

• peripheral muscle dysfunction
• dynamic hyperinflation
• increased respiratory load
• defective gas exchange
• age-related decline in function
• physical deconditioning
• comorbid conditions

The exertional dyspnea in COPD is usually multifactorial:

- peripheral muscle dysfunction
- dynamic hyperinflation
- increased respiratory load
- defective gas exchange
- age-related decline in function
- physical deconditioning
- comorbid conditions

- exercise training lead to improved oxidative capacity and efficiency of the skeletal muscles leads to a reduced ventilatory requirement for a given submaximal work rate

- Reduced ventilatory requirement leads to reduction in dynamic hyperinflation

- Reconditioning of Muscle groups
- Reduced mood disturbance
- Reduced symptom burden
- Improved cardiovascular function

Chest 2005;128:2025–2034
Before starting an exercise program

• Exercise assessment to individualize prescription
• Potential need to supplement oxygen
• Rule out cardiovascular comorbidity
• CPET : optional
• Identifying single variable is difficult
Principles of Exercise training

• Total training load must reflect individuals specific requirements
• Must exceed loads encountered in ADL
• Must progress as improvement occurs
Types of exercise in COPD

Conventional Exercise Types
- Endurance Training: Walking, Cycling, Stair climbing
- Interval Training: Cycling

Alternative Exercise Types
- Water-based Training: Swimming, Aquasize
- Nordic Walking Training: Walking with diagonal locomotion
- Resistance Training: Weight lifting of light loads
- Ground Walking Training: Walking
- T’ai Chi Training: Circular movements, Balance, Light weights
- Nonlinear Periodized Training: Mix of Aerobic, Anaerobic & Resistance exercise
Modes of Exercise training

- Endurance training
- Interval training
- Resistance training
- Neuromuscular electrical stimulation
- Respiratory muscle training.
Endurance Training

• **Aims**
  - Condition muscles of ambulation
  - Improve cardiorespiratory fitness

• **FITT**
  - Frequency
  - Intensity
  - Time
  - Type

• Endurance exercise training in the form of cycling or walking exercise is the most common type of applied exercise modality in pulmonary rehabilitation.

• Endurance exercise training in individuals with chronic respiratory disease is prescribed at the frequency of three to five times per week.

• A high level of intensity of continuous exercise (60% maximal work rate) for 20 to 60 minutes (time) per session.

• Maximizes physiologic benefits:
  • exercise tolerance
  • muscle function
  • bioenergetics

• A Borg dyspnea or fatigue score of 4 to 6 (moderate to [very] severe) is often considered a target training intensity.
Nordic Walking improves daily physical activities in COPD: a RCT
Nordic Walking improves daily physical activities in COPD: a RCT

- **P:** 60 COPD patients
- **I:** one hour nordic walking at 75% maximal heart rate (3 month follow up, analysis after 6 weeks)
- **C:** No active exercise
- **O:** Daily physical activities

*Respir Res 2010;11:112.*
Interval Training

• Interval training: an alternative to standard endurance training

• a modification of endurance training in which high-intensity exercise is regularly interspersed with periods of rest or lower intensity exercise.

• This results in significantly lower symptom scores despite high absolute training loads, thus maintaining the training effects of endurance training.

• Eur Respir J 2002;20:12–19
• Eur Respir J 2010;36:301–310
Interval versus continuous training

Abstract

Background In patients with chronic obstructive pulmonary disease (COPD), interval exercise has gained recent attention as a possible means of achieving greater physiological training effects compared with continuous exercise. The primary aim of this systematic review was to compare the effects of interval versus continuous training on peak oxygen uptake, peak power, 6 minute walk test (6MWT) distance and health-related quality of life in individuals with COPD.

Methods Randomised controlled trials comparing the effects of interval versus continuous training in patients with COPD were identified after searches of six databases and reference lists of appropriate studies in May 2009. Two reviewers independently assessed study quality. Weighted mean differences (WMD) with 95% CIs were calculated using a random effects model for measures of exercise capacity and health-related quality of life.

Results: Eight randomised controlled trials, with a total of 388 patients with COPD, met the inclusion criteria. No significant differences were found for peak power (WMD 1 W, 95% CI −1 to 3) or peak oxygen uptake (WMD −0.04 l/min, 95% CI −0.13 to 0.05) between interval and continuous training. The WMD for the Chronic Respiratory Questionnaire dyspnoea score was −0.2 units (95% CI −0.5 to 0.0). There was no difference in 6MWT distance between groups (WMD 4 m, 95% CI −15 to 23).

Conclusions Interval and continuous training modalities did not differ in their effect on measures of exercise capacity or health-related quality of life. Interval training may be considered as an alternative to continuous training in patients with varying degrees of COPD severity.
• For individuals with chronic heart failure a high-intensity interval training program was superior to moderate-intensity continuous training at matched work for both exercise capacity and quality of life.

• Circulation 2007;115:3086–3094
Resistance/Strength Training

- Resistance (or strength) training is an exercise modality in which local muscle groups are trained by repetitive lifting of relatively heavy loads
- Improved muscle mass
- Reduced risk of falling
- Improving BMD

[Am J Respir Crit Care Med 2002;166:809–813]
Endurance training: suboptimal increases in muscle mass or strength compared with programs that include specific resistance exercise

Moreover, strength training results in less dyspnea during the exercise period, thereby making this strategy easier to tolerate than endurance constant-load training.

References:
• Chest 2004;125:2036–2045
• No optimal resistance training prescription
• 1 to 3 sets of 8 to 12 repetitions should be undertaken on 2 to 3 days each week
• The exercise dosage must increase over time (the so-called overload) to facilitate improvements in muscular strength and endurance.

•Chest 2009;136:1269–1283
• When added to a program of endurance constant-load exercise, resistance training confers additional benefits in muscle force, but not in overall exercise capacity or health status.
• the combination of constant-load/interval and strength training improves outcome to a greater degree than either strategy alone in individuals with chronic respiratory disease, without unduly increasing training time

•Am J Respir Crit Care Med 2002;166:669–674.
Upper Limb Training

• Examples of upper extremity exercises include
  • aerobic regimens
    » arm cycle ergometer training
  • resistance training
    » training with free weights
    » Training with elastic bands
Upper extremity training

- increases upper limb function
- the optimal approach to training remains to be determined.
- to what extent specific gains in upper limb function translate into improvements in health related quality of life is not clear

• Chest 2009;136:387–395
• Chest 2011;139:151–158
Flexibility Training

• Although flexibility training is a component of many exercise regimens in pulmonary rehabilitation, there are, to date, no clinical trials demonstrating its effectiveness in this particular setting.
Neuromuscular Electrical Stimulation

• Transcutaneous neuromuscular electrical stimulation (NMES) of skeletal muscle is an alternative rehabilitation technique wherein muscle contraction is elicited, and selected muscles can thereby be trained, without the requirement for conventional exercise.

• Muscle contraction induced by electrical stimulation
  • does not lead to dyspnea,
  • minimal cardiocirculatory demand,
  • bypasses the cognitive, motivational, and psychological aspects that may hinder or prevent effective exercise training.

• Respir Med 2008;102:786–789
• The mechanisms by which NMES improves muscle function and exercise capacity or performance are incompletely understood.
• The pattern of muscle fiber activation during NMES may differ from that which occurs during conventional exercise.
• Specifically, the frequency of stimulus delivered likely determines the types of muscle fibers activated.
• A NMES stimulus frequency up to 10 Hz likely preferentially activates slow twitch fibers and may selectively improve resistance to fatigue, whereas a frequency greater than 30 Hz may activate both types of fibers, or may selectively recruit fast-twitch fibers and enhance power.

• Crit Care 2010;14:R74.
• Phys Ther 2005;85:358–364
• Frequencies ranging between 35 to 50 have been used for COPD
• Some investigators advocate delivery of a combination of stimulus frequencies during NMES training to most closely mimic normal motor neuron firing patterns and have maximal impact on muscle function.
• There are no formal patient candidacy guidelines for NMES.
• NMES is safe and generally well tolerated. The adverse effect reported most commonly is mild muscle soreness that usually resolves after the first few NMES session

• Contraindications like pacemaker devices and implanted defibrillator are expert opinion

Inspiratory Muscle Training

• The pressure-generating capacity of the inspiratory pump muscles is reduced in individuals with COPD

• Endurance exercise training, despite conferring large gains in exercise capacity and reducing dyspnea, does not appear to improve the pressure-generating capacity of the inspiratory muscles, likely because the ventilatory load during whole-body exercise is of insufficient magnitude to confer a training adaptation

• Am J Respir Crit Care Med 2002;166:809–813
Inspiratory Muscle Training in Patients with Chronic Obstructive Pulmonary Disease: The State of the Evidence

The clinical benefits of improved inspiratory muscle strength and endurance resulting from IMT appear to include improvements in dyspnea, walking test distance, and HRQL.

However, the strength of these conclusions must be considered in the context of several limitations to the body of evidence regarding the use of IMT in individuals with COPD.

Additionally, it is not clear who would benefit most from IMT and what training regimen is optimal.
Guidelines

Table 3.5. Benefits of Pulmonary Rehabilitation in COPD

- Improves exercise capacity (Evidence A).
- Reduces the perceived intensity of breathlessness (Evidence A).
- Improves health-related quality of life (Evidence A).
- Reduces the number of hospitalizations and days in the hospital (Evidence A).
- Reduces anxiety and depression associated with COPD (Evidence A).
- Strength and endurance training of the upper limbs improves arm function (Evidence B).
- Benefits extend well beyond the immediate period of training (Evidence B).
- Improves survival (Evidence B).
- Respiratory muscle training can be beneficial, especially when combined with general exercise training (Evidence C).
- Improves recovery after hospitalization for an exacerbation (Evidence A).
- Enhances the effect of long-acting bronchodilators (Evidence B).
Guidelines

• All patients who get short of breath when walking on their own pace on level ground should be offered rehabilitation; it can improve symptoms, quality of life, and physical and emotional participation in everyday activities.
<table>
<thead>
<tr>
<th>U11</th>
<th>NEW 2010 UPDATE RECOMMENDATION 11 (U11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pulmonary rehabilitation should be made available to all appropriate people with COPD (see R84) including those who have had a recent hospitalisation for an acute exacerbation.</td>
</tr>
</tbody>
</table>

| R84 | Pulmonary rehabilitation should be offered to all patients who consider themselves functionally disabled by COPD (usually MRC grade 3 and above). Pulmonary rehabilitation is not suitable for patients who are unable to walk, have unstable angina or who have had a recent myocardial infarction. |

| R85 | For pulmonary rehabilitation programmes to be effective, and to improve concordance, they should be held at times that suit patients, and in buildings that are easy for patients to get to and have good access for people with disabilities. Places should be available within a reasonable time of referral. |

| R86 | Pulmonary rehabilitation programmes should include multicomponent, multidisciplinary interventions, which are tailored to the individual patient’s needs. The rehabilitation process should incorporate a programme of physical training, disease education, nutritional, psychological and behavioural intervention. |
Guidelines

• What is the role of pulmonary rehabilitation?
• 1. Structured pulmonary rehabilitation programs should be set up where feasible. (1A)
• 2. In the absence of structured programs, patients should be advised regarding unsupervised daily physical activity. (3A)
Pulmonary rehabilitation for chronic obstructive pulmonary disease (Review)
CRQ

- **Description:** CRQ is an interviewer-administered questionnaire measuring both physical and emotional aspects of chronic respiratory disease.
- **Developer:** GH Guyatt MD
- **Administration:** Interview
- **Time to complete:** 15-25 minutes
- **Number of items:** 20
- **Domains & categories:** 4 categories: Dyspnea, fatigue, emotional function, mastery
- **Scoring:** Total score and subscores on categories; higher scores indicate better health-related quality of life
- A change in the score of 0.5 on the 7 point scale, reflects a clinical significant small change. A change of 1.0 reflects a moderate change and a difference of 1.5 represents a large change.
- **Minimally important difference:** Reflected by a change in score of 0.5 on a 7 point scale.
The SGRQ is a 50-item questionnaire developed to measure health status (quality of life) in patients with diseases of airways obstruction. Scores are calculated for three domains: Symptoms, Activity and Impacts (Psycho-social) as well as a total score. Psychometric testing has demonstrated its repeatability, reliability and validity. Sensitivity has been demonstrated in clinical trials. A minimum change in score of 4 units was established as clinically relevant after patient and clinician testing.

The SGRQ has been used in a range of disease groups including asthma, chronic obstructive pulmonary disease (COPD) and bronchiectasis, and in a range of settings such as randomised controlled therapy trials and population surveys. The SGRQ correlates significantly with other measures of disease activity such as cough, dyspnoea, 6-min walk test and FEV1 as well as other measures of general health such as the SIP and SF36.

• **Background**

Widespread application of pulmonary rehabilitation in COPD should be preceded by demonstrable improvements in function (health-related quality of life, functional and maximal exercise capacity) attributable to the programmes.

• **Objectives**

To compare the effects of pulmonary rehabilitation versus usual care on health-related quality of life and functional and maximal exercise capacity in persons with COPD.
• **Search methods**

Randomised controlled trials (RCTs) from the Cochrane Airways Group Specialised Register. Searches were current as of March 2014.
Selection criteria

• RCTs of pulmonary rehabilitation in patients with COPD in which health-related quality of life (HRQoL) and/or functional (FEC) or maximal (MEC) exercise capacity were measured.

• Pulmonary rehabilitation was defined as exercise training for at least four weeks with or without education and/or psychological support.

• Usual care was defined as conventional care in which the control group was not given education or any form of additional intervention.
1. CRQ
   A. Fatigue
   B. Emotional function
   C. Mastery
   D. Dyspnea

2. SGRQ
   A. Total
   B. Symptoms
   C. Impact
   D. Activity

3. Maximal Exercise (ISWT)
4. Maximal Exercise capacity (cycle ergometer)
5. Functional Exercise capacity (6 MWD)
Rehabilitation versus usual care, Outcome 4 QoL - Change in CRQ (Dyspnoea)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative effects* (95% CI)</th>
<th>Number of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Response on control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual care</td>
<td>Median change = 0 units</td>
<td>1283 (19 studies)</td>
<td>✫✫✫✫ Moderate\textsuperscript{1,2,3}</td>
</tr>
<tr>
<td>Rehabilitation versus usual care</td>
<td>Mean QoL - change in CRQ (Dyspnoea) in the intervention groups was 0.79 units higher (0.56 to 1.03 higher)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CRQ Questionnaire. Scale from 1 to 7 (Higher is better and 0.5 unit is an important difference) Follow-up: median 12 weeks
## Rehabilitation versus usual care, Outcome 5 QoL - Change in SGRQ (Total)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative effects* (95% CI)</th>
<th>Number of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Response on control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rehabilitation versus usual care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QoL - Change in SGRQ (total)</td>
<td>Median change = 0.42 units</td>
<td>1146 (19 studies)</td>
<td>⭐⭐⭐⭐⭐ Moderate²,³,⁴</td>
</tr>
<tr>
<td></td>
<td>Mean QOL - change in SGRQ (total) in the intervention groups was 6.89 units lower</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(9.26 to 4.52 lower)</td>
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</tbody>
</table>

Scale from 0 to 100
(Lower is better and 4 units is an important difference)
Follow-up: median 12 weeks
Rehabilitation versus usual care, Maximal Exercise (Incremental shuttle walk test)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative effects* (95% CI)</th>
<th>Number of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Response on control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual care</td>
<td>Rehabilitation versus usual care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in maximal exercise (Incremental Shuttle walk test (ISWT))</td>
<td>Median change = 1 metre</td>
<td>694 (8 studies)</td>
<td>moderate2,3,5</td>
</tr>
<tr>
<td>Distance metres</td>
<td>Mean maximal exercise (incremental shuttle walk test) in the intervention groups was</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up: median 12 weeks</td>
<td>39.77 metres higher (22.38 to 57.15 higher)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rehabilitation versus usual care, Functional Exercise Capacity (6MWT)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative effects* (95% CI)</th>
<th>Number of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in functional exercise capacity (6MWT)</td>
<td>Median change = 3.4 metres</td>
<td>1879 (38 studies)</td>
<td>☣️ ☣️ ☣️ ☣️ (Very low)</td>
<td></td>
</tr>
<tr>
<td>Distance metres</td>
<td>Mean functional exercise capacity (6MWT) in the intervention groups was 43.93 metres higher (32.64 to 55.21 higher)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Follow-up: median 12 weeks</td>
<td></td>
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</tr>
</tbody>
</table>
Rehabilitation versus usual care, Maximal Exercise Capacity (cycle ergometer)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative effects* (95% CI)</th>
<th>Number of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response on control</td>
<td>Treatment effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual care</td>
<td>Rehabilitation versus usual care</td>
<td>779 (16 studies)</td>
<td>Low²,³,⁸,⁹</td>
</tr>
<tr>
<td>Median change = -0.05 watts</td>
<td>Mean maximal exercise capacity (cycle ergometer) in the intervention groups was 6.77 watts higher (1.89 to 11.65 higher)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rehabilitation versus usual care (subgroup analysis hospital vs community)

• Evidence suggested a significant difference in treatment effect between subgroups for all domains of the CRQ, with higher mean values, on average, in the PR group in hospital than in the community-based group.

• No subgroup differences were reported for any of the SGRQ domains
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Subscale</th>
<th>Subgroups</th>
<th>Heterogeneity</th>
<th>MD [95% CI]</th>
<th>Test for subgroup differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRQ</td>
<td>Fatigue</td>
<td>Community</td>
<td>Tau² = 0.10;</td>
<td>0.44 [0.14,</td>
<td>Chi² = 3.98, df = 1 (P value 0.05), I² = 74.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>I² = 52%</td>
<td>0.75]</td>
<td></td>
</tr>
<tr>
<td>CRQ</td>
<td>Emotional</td>
<td>Community</td>
<td>Tau² = 0.00;</td>
<td>0.21 [0.04,</td>
<td>Chi² = 12.24, df = 1 (P value 0.0003), I² = 91.8%</td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td>Hospital</td>
<td>I² = 0%</td>
<td>0.39]</td>
<td></td>
</tr>
<tr>
<td>CRQ</td>
<td>Mastery</td>
<td>Community</td>
<td>Tau² = 0.07;</td>
<td>0.40 [0.12,</td>
<td>Chi² = 8.58, df = 1 (P value 0.003), I² = 88.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>I² = 45%</td>
<td>0.67]</td>
<td></td>
</tr>
<tr>
<td>CRQ</td>
<td>Dyspnoea</td>
<td>Community</td>
<td>Tau² = 0.03;</td>
<td>0.58 [0.34,</td>
<td>Chi² = 4.05, df = 1 (P value 0.04), I² = 75.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>I² = 26%</td>
<td>0.81]</td>
<td></td>
</tr>
<tr>
<td>SGRQ</td>
<td>Total</td>
<td>Community</td>
<td>Tau² = 24.00;</td>
<td>-8.15 [-12.16, -4.13]</td>
<td>Chi² = 0.69, df = 1 (P value 0.41), I² = 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>I² = 73%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGRQ</td>
<td>Symptoms</td>
<td>Community</td>
<td>Tau² = 6.28;</td>
<td>-3.66 [-7.07, -0.24]</td>
<td>Chi² = 1.65, df = 1 (P value 0.20), I² = 39.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>I² = 24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGRQ</td>
<td>Impact</td>
<td>Community</td>
<td>Tau² = 19.91;</td>
<td>-8.17 [-12.00, -4.34]</td>
<td>Chi² = 0.46, df = 1 (P value 0.50), I² = 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>I² = 63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGRQ</td>
<td>Activity</td>
<td>Community</td>
<td>Tau² = 48.91;</td>
<td>-7.82 [-13.37, -2.28]</td>
<td>Chi² = 0.93, df = 1 (P value 0.33), I² = 0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>I² = 78%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tau² = 10.45;</td>
<td>-4.58 [-8.16, -1.00]</td>
<td></td>
</tr>
</tbody>
</table>
Rehabilitation versus usual care (subgroup analysis ’exercise only’ vs ’exercise plus more comprehensive components’)

- No evidence was found of a significant treatment effect between subgroups for all domains of the CRQ and the SGRQ
AUTHORS’ CONCLUSIONS

• Clinically and statistically significant improvements in important domains of health-related quality of life, including dyspnoea, fatigue, emotional function and mastery, in addition to the sixminute walk/distance test - a measure of functional exercise.

• With the support of current international statements or clinical practice guidelines targeting respiratory rehabilitation in COPD, we hope that the results of this meta-analysis will encourage the implementation of new programmes.
AUTHORS’ CONCLUSIONS

• Overall, the conclusions of this meta-analysis are in agreement with those of prior meta-analyses published in 1996 and in 2001
• The addition of 34 RCTs since the 2006 update resulted, as expected, in narrowing of the CIs around the common effects of rehabilitation in the outcomes examined.
AUTHORS’ CONCLUSIONS

• The subgroup analysis finding that identified a difference in treatment effect between hospital-based programmes and community-based programmes suggests that further research should be undertaken to compare these two approaches.

• Similarly, the fact that the subgroup analysis identified no differences between basic exercise PR programmes and those that provided more complex interventions suggests the need to examine and identify the most essential components of PR programmes for achieving the best patient outcomes.
## Diseases other than COPD

<table>
<thead>
<tr>
<th>Population</th>
<th>Evidence for PR</th>
<th>Outcomes of PR</th>
<th>Special Considerations</th>
</tr>
</thead>
</table>
| Interstitial lung disease | Two RCTs of exercise training*; one systematic review^ | • Improved 6 min walk distance, dyspnea, and quality of life.  
• Magnitude of benefits smaller than that seen in COPD  
• Benefits not maintained at 6 mo | Supplemental oxygen should be available and appropriate monitoring of oxyhemoglobin saturation during exercise is indicated  |

*Thorax 2008;63: 549–554
^Cochrane Database Syst Rev 2008;4:CD006322
Diseases other than COPD

<table>
<thead>
<tr>
<th>Population</th>
<th>Evidence for PR</th>
<th>Outcomes of PR</th>
<th>Special Considerations</th>
</tr>
</thead>
</table>
| Bronchiectasis   | One RCT of exercise +/- inspiratory muscle training*; one large retrospective study of standard PR ^ | • Improvement in incremental shuttle walk test distance & endurance exercise time.  
• Benefits of equivalent magnitude to those seen in COPD | Role of airway clearance techniques not yet established                       |

*Thorax 2005;60:943–948  
^Chron Respir Dis 2011;8:21–30
## Diseases other than COPD

<table>
<thead>
<tr>
<th>Population</th>
<th>Evidence for PR</th>
<th>Outcomes of PR</th>
<th>Special Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>One systematic review *; two RCTs of exercise training(^)</td>
<td>Improved physical fitness, asthma symptoms, anxiety, depression, and quality of life</td>
<td>Preexercise use of bronchodilators and gradual warm up are indicated to minimize exercise induced Bronchospasm</td>
</tr>
</tbody>
</table>

*^Chest 2010;138:331–337  
*Respiration 2011;81:302–310  
*^Cochrane Database Syst Rev. 2005;4:CD001116
# Diseases other than COPD

<table>
<thead>
<tr>
<th>Population</th>
<th>Evidence for PR</th>
<th>Outcomes of PR</th>
<th>Special Considerations</th>
</tr>
</thead>
</table>
| Pulmonary Hypertension    | One RCT *; two prospective case series ^                  | Improved exercise endurance, WHO functional class, quality of life, increased peripheral muscle function. | • supplemental O2 should be available  
• BP and pulse should be monitored closely  
• Concurrent arm/leg exercises are generally not recommended |

*Circulation 2006;114:1482–1489  
^Cardiopulm Rehabil Prev 2010;30:319–323  
Respiration 2011;81:394–401
### Diseases other than COPD

<table>
<thead>
<tr>
<th>Population</th>
<th>Evidence for PR</th>
<th>Outcomes of PR</th>
<th>Special Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung cancer Pre op</td>
<td>Small observational studies</td>
<td>Improved exercise tolerance</td>
<td>Short duration e.g. 2-4 wk, up to 5 times per week</td>
</tr>
<tr>
<td>Post op</td>
<td>One systemic review*</td>
<td>Increased walking endurance, increased peak exercise capacity, reduced dyspnea and fatigue</td>
<td></td>
</tr>
<tr>
<td>Medical Management</td>
<td>Case series^</td>
<td>Improved symptoms and maintenance of muscle strength</td>
<td></td>
</tr>
</tbody>
</table>

* Lund Cancer 2011;72:139–153
## Diseases other than COPD

<table>
<thead>
<tr>
<th>Population</th>
<th>Evidence for PR</th>
<th>Outcomes of PR</th>
<th>Special Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung Transplant Pretansplant</td>
<td>One RCT comparing interval versus continuous training*</td>
<td>Improved exercise tolerance and wellbeing</td>
<td>Lower intensity or interval training Educational component should cover surgical techniques, risks, benefits of the surgery, postoperative care</td>
</tr>
<tr>
<td>Post Transplant</td>
<td>Two RCTs^</td>
<td>Increased muscle strength, walking endurance, maximal exercise capacity, and quality of life</td>
<td></td>
</tr>
</tbody>
</table>

*J Heart Lung Transplant 2012;31:934–941  
^J Heart Lung Transplant 2010;29:497–503  
Am J Transplant 2008;8:1275–1281
Program Organization in Pulmonary Rehabilitation

- Barriers
- Staffing
- Duration
- Setting
Barriers

• Inconvenience for the patient
• Lack of perceived benefit
• Transportation/travel issues
• Cost
• Illness severity
• Comorbidities
• Mood disorders
• Smoking
Staffing

The American Association of Cardiovascular and Pulmonary Rehabilitation recommends a staff-to-participant ratio of 1:4, and the British Thoracic Society a ratio of 1:8
<table>
<thead>
<tr>
<th>Health Care Provider</th>
<th>Suggested Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest physician (preferably with pulmonary</td>
<td>Medical treatment and patient referral</td>
</tr>
<tr>
<td>rehabilitation specialty)</td>
<td>Diagnosis and follow-up of comorbidities</td>
</tr>
<tr>
<td></td>
<td>Setup and supervision of multidisciplinary team</td>
</tr>
<tr>
<td></td>
<td>Referral for comorbidities</td>
</tr>
<tr>
<td>Exercise specialist (physiotherapist)</td>
<td>Setup and supervision of the exercise program</td>
</tr>
<tr>
<td></td>
<td>Home exercise program (follow-up)</td>
</tr>
<tr>
<td></td>
<td>Arrangement of maintenance training strategies</td>
</tr>
<tr>
<td>Psychologist</td>
<td>Management of uncertainty\textsuperscript{23}</td>
</tr>
<tr>
<td></td>
<td>Management of depression in depressed patients\textsuperscript{24,a}</td>
</tr>
<tr>
<td></td>
<td>Smoking cessation</td>
</tr>
<tr>
<td>Occupational therapist</td>
<td>Home energy efficiency\textsuperscript{25}</td>
</tr>
<tr>
<td></td>
<td>Specific training of home activities\textsuperscript{26}</td>
</tr>
<tr>
<td></td>
<td>Use of walking aids</td>
</tr>
<tr>
<td></td>
<td>Pacing techniques</td>
</tr>
<tr>
<td>Nutritional experts</td>
<td>Management of overweight</td>
</tr>
<tr>
<td></td>
<td>Management of cachexia</td>
</tr>
<tr>
<td></td>
<td>Nutrient intake in line with exercise training program</td>
</tr>
<tr>
<td></td>
<td>Nutritional supplements</td>
</tr>
<tr>
<td>Nurse specialist</td>
<td>Medication adherence</td>
</tr>
<tr>
<td></td>
<td>Smoking cessation</td>
</tr>
<tr>
<td></td>
<td>Self-management program for exacerbation management</td>
</tr>
<tr>
<td>Physiotherapist</td>
<td>Mucous clearance in patients with mucous hypersecretion and difficulties to clear</td>
</tr>
<tr>
<td></td>
<td>spontaneously\textsuperscript{5}</td>
</tr>
<tr>
<td></td>
<td>Balance/proprioceptive training in frail patients at risk for falling\textsuperscript{27}</td>
</tr>
<tr>
<td>Social worker</td>
<td>Solve transportation issues in outpatient programs</td>
</tr>
<tr>
<td></td>
<td>Map out the social support network around a patient to anticipate on dropout</td>
</tr>
<tr>
<td></td>
<td>Implementation of social support measures provided by the health care system to</td>
</tr>
<tr>
<td></td>
<td>alleviate financial burden</td>
</tr>
</tbody>
</table>
Indian Scenario

Correlation of health-related quality of life with other disease severity indices in Indian chronic obstructive pulmonary disease patients
Indian Scenario

Investigation and treatment on these selected components, it is hoped that patients with COPD might lead fuller and more satisfying lives. Antidepressants are helpful for psychological disturbances, bronchodilators and narcotics can help dyspnea, and pulmonary rehabilitation programs, which are a rarity in India, show functional improvement of the 6-minute walk. Improvements in peer groups and family support may benefit patients by providing more social structure.

Measures of perceived severity of illness (CLD) and dyspnea (MRC) likewise showed tight correlation with QOL.

•International Journal of COPD 2012:7 291–296
Steps of pulmonary rehabilitation in resource-poor settings

- Assess the patient with spirometry, saturation, 6MWT, weight
- Exercise training by a trained staff, or an assistant at the time of enrolment for 30 minutes
- The exercise should simulate the patient’s home environment
- The endurance and strength training can be done by walking/cycling, walking uphill/climbing stairs and straight leg raise, respectively
- The exercise should be guided by his ability to tolerate exercise and 6 MWT with periods of rest if desired. The speed and distance should be increased gradually
- The patients should exercise twice in a day for 30 minutes for at least 5 to 6 days in a week
- The patient may follow up once in a week or 15 days for reinforcement/increment/supervision of exercises

Future directions

• EXPANDING THE APPLICABILITY OF PULMONARY REHABILITATION
  • Pulmonary Rehabilitation During Critical Illness
  • Pulmonary Rehabilitation in the Home and Community Settings
  • Technology-Assisted Pulmonary Rehabilitation
  • Pulmonary Rehabilitation for the Non-COPD Respiratory Patient
Future Directions

• FURTHER DEFINING THE EFFECTIVENESS OF PULMONARY REHABILITATION
  • Self-Management Education
  • Maintaining the Benefits of Pulmonary Rehabilitation
Future Directions

• PROMOTING ACCESSIBILITY TO PULMONARY REHABILITATION
  • Increasing the Awareness of Pulmonary Rehabilitation
  • Fair Reimbursement for Pulmonary Rehabilitation
• A program of exercise training of the muscles of ambulation is recommended as a mandatory component of pulmonary rehabilitation for patients with COPD.

• Grade of Recommendation: 1A

• 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)
ATS/ERS

- Pulmonary rehabilitation improves the symptom of dyspnea in patients with COPD.
- Grade of Recommendation: 1A

BTS

- 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)
ATS/ERS

• Pulmonary rehabilitation improves health related quality of life in patients with COPD.

• Grade of Recommendation: 1A
ATS/ERS

- Pulmonary rehabilitation reduces the number of hospital days and other measures of health-care utilization in patients with COPD
- *Grade of Recommendation: 2B*

BTS

- a priori opted not to evaluate healthcare utilization costs.
Pulmonary rehabilitation is cost-effective in patients with COPD.

Grade of Recommendation: 2C
• There is insufficient evidence to determine if pulmonary rehabilitation improves survival in patients with COPD. No recommendation is provided.
ATS/ERS

- There are psychosocial benefits from comprehensive pulmonary rehabilitation programs in patients with COPD.
- *Grade of Recommendation: 2B*

BTS

- Pulmonary rehabilitation should be offered to patients with COPD with a view to improving psychological wellbeing.
- *(Grade A)*
ATS/ERS

- Six to 12 weeks of pulmonary rehabilitation produces benefits in several outcomes that decline gradually over 12 to 18 months.
- *(Grade of Recommendation: 1A)*

BTS

- Pulmonary rehabilitation programmes of 6–12 weeks are recommended. *(Grade A)*
ATS/ERS

• Lower-extremity exercise training at higher exercise intensity produces greater physiologic benefits than lower-intensity training in patients with COPD.
• Grade of Recommendation: 1B

BTS

• the relative merits of different components of training (eg. resistance vs aerobic; upper limb vs lower limb)
• unanswered
ATS/ERS

- Current scientific evidence does not support the routine use of anabolic agents in pulmonary rehabilitation for patients with COPD.
- *Grade of Recommendation: 2C*

BTS

- No specific hormonal or nutritional supplement can currently be recommended as a routine adjunct to pulmonary rehabilitation.
- (Grade B)
ATS/ERS

• Unsupported endurance training of the upper extremities is beneficial in patients with COPD and should be included in pulmonary rehabilitation programs.

• *Grade of Recommendation: 1A*

BTS

• the relative merits of different components of training (eg. resistance vs aerobic; upper limb vs lower limb)

• unanswered
ATS/ERS

- The scientific evidence does not support the routine use of inspiratory muscle training as an essential component of pulmonary rehabilitation.
  
  *Grade of Recommendation: 1B*

BTS

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

- Education should be an integral component of pulmonary rehabilitation. Education should include information on collaborative self-management and prevention and treatment of exacerbations.

- Grade of Recommendation: 1B
ATS/ERS

• There is insufficient evidence to support the routine use of nutritional supplementation in pulmonary rehabilitation of patients with COPD. No recommendation is provided.
ATS/ERS

• Pulmonary rehabilitation is beneficial for some patients with chronic respiratory diseases other than COPD
• Grade of Recommendation: 1B

BTS

• General exercise should be encouraged for all patients with chronic respiratory disease. (√)
Take Home Message

• Evidence strongly support pulmonary rehabilitation, including at least four weeks of exercise training, as part of the spectrum of treatment for patients with COPD

• Pulmonary rehabilitation has long been underused in patients with COPD

• Additional RCTs comparing PR and conventional care in COPD are no longer warranted.
Take Home Message

• Factors that remain uncertain include the degree of supervision, the intensity of the training and how long the treatment effect persists.

• These specific issues demand further elucidation through RCTs and further meta-analysis
Take Home Message

• There is an urgent need to establish pulmonary rehabilitation programs in India and offer patients the benefit of same above the “usual care”