Swiss Medical Weekly
Formerly: Schweizerische Medizinische Wochenschrift
The European Journal of Medical Sciences

Review article | Published 1 September 2010, doi:10.4414/smw.2010.13067
Cite this as: Swiss Med Wkly. 2010;140:w13067

Making pulmonary rehabilitation a success in COPD

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Summary

A truly successful pulmonary rehabilitation entails implementing physical activity maintenance. This article reviews the current knowledge on pulmonary rehabilitation and the expected benefits, the setting, the relationship between self-management and pulmonary rehabilitation, in order to develop and implement clinically-effective physical activity maintenance interventions.

The effectiveness of pulmonary rehabilitation is well-established. However, access to pulmonary rehabilitation is limited. Home-based pulmonary rehabilitation has been shown to be an effective, equivalent alternative to outpatient pulmonary rehabilitation in COPD patients. The opportunity to offer different pulmonary rehabilitation settings tailored to individual needs should improve accessibility to this intervention.

Sustained long-term physical activity remains the most important challenge for COPD patients. We need a dependable system of coordinated health care interventions and communication, and components that include self-management support. Self-management should be an integrated part of pulmonary rehabilitation and remain long after the pulmonary rehabilitation is completed. By early identification of patients who may have difficulty maintaining exercise and implementing appropriate self-management interventions during and after the rehabilitation program, it may be possible to promote better long-term involvement in physical activity.

Pulmonary rehabilitation should not stand alone; the best program is that which can be maintained to translate into a continuous increase in the activities of daily living. Future research should evaluate the effect of self-management interventions combined with pulmonary rehabilitation to improve long-term activity and exercise maintenance.

Key words: *pulmonary rehabilitation; COPD; self-management; physical activity*

Introduction

In the trajectory of a chronic illness such as COPD, patients and their family are in a constant process of learning new skilled behaviours required for appropriate disease management. Pulmonary rehabilitation, which has well established effectiveness [1], is increasingly becoming a realistic component of COPD patient management [2]. It offers the opportunity to optimise independent physical activity and self-health behaviours for better disease control and coping.

However, pulmonary rehabilitation should not stand as an isolated, albeit multidimensional intervention. It should be part of an integrated care process and include self-management support, aiming to achieve a shift from management by the health care provider to management by patients themselves, which implies behaviour change. A truly successful pulmonary rehabilitation entails implementing physical activity maintenance. Patients who maintain activity have less dyspnea during daily activity, better health-related quality of life [3], and enhanced long-term functional [4], physiological and psychological outcomes [5]. Clinicians need guidance in helping patients to maintain physical activity, and in the specific areas on which to focus interventions.

From this article, you will gain knowledge on pulmonary rehabilitation, hospital and home-based programs, and what benefits to expect. This review will also explore the relationship of self-management and pulmonary rehabilitation in order to develop and implement effective physical activity maintenance interventions and understand their implications for the future.

Pulmonary rehabilitation, the clinical evidence

The contribution over the last fifteen years of research in the field of pulmonary rehabilitation in patients with COPD has been tremendous. Rehabilitation programs for patients with COPD are well-established as a means of enhancing standard therapy in order to control and alleviate symptoms, optimise functional capacity and improve health-related quality of life [6, 7]. Structured rehabilitation programs generally offer education, psychosocial support and regular physical exercise training. Figure 1 shows the benefits of pulmonary rehabilitation from the most recent Cochrane review [6]. Results of these well designed trials have been quite consistent in COPD.

The increase in functional capacity following aerobic training has been related to peripheral muscle physiological adaptation; the degree of improvement (i.e., performance) being proportional to the training intensity [8–13]. The addition of strength training to aerobic training (i.e., combined modality training) has been shown to improve muscle function (strength and mid-thigh muscle cross-sectional area) but has no further improvement in exercise tolerance [14].

Is high better than low intensity? Exercise-induced improvements in dyspnea, quality of life, functional capacity and mobility have also been reported following low to moderate intensity exercise training that did not result in changes in cardio respiratory function or peripheral muscle adaptation [15, 16]. The most important focus is on improving health.

Pulmonary rehabilitation, the basis of physiology of exercise training

The increased work capacity and decreased breathlessness for a given sub-maximal effort following exercise training has been well documented. A surcharge is necessary to produce a biological adaptation. The physiological responses to training consist of structural changes in the cardiovascular and peripheral muscle systems; this accounts for an improvement in the capacity to transport oxygen and in the respiratory capacity of the trained peripheral muscles. As a result, peak VO_2 (oxygen consumption) will improve with aerobic training.

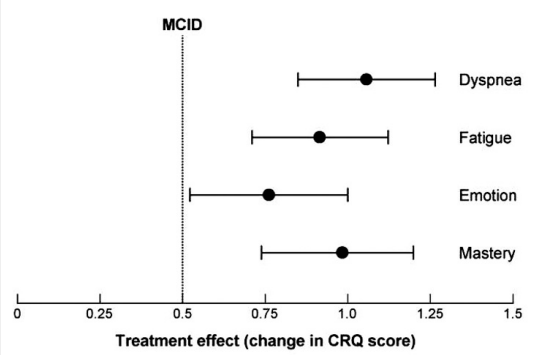

Figure 1

Effects of pulmonary rehabilitation in patients with COPD [6].

In COPD, it has been shown that, with aerobic training, there is a conversion from fast, low oxidative and fatigable fibre type (type II), to a slow high oxidative and fatigue-resistant fibre type (type I). The volume of type I and the mitochondrial numbers are expanded; also, the activities of the mitochondrial enzymes such as citrate synthase and 3 hydroxyacyl-CoA dehydrogenises are enhanced [17]. Increases in muscle capillaries have also been noticed. This facilitates oxygen delivery and extraction. Changes in the muscle metabolism during exercise are thought to contribute to the greater tolerance of sub-maximal exercise, which may be particularly relevant to activities of daily living.

Furthermore, there is a reduction in the breathing stimulus "reduction in the excessive afferent chemoreflex activation leading to an excess ventilatory drive". Change in skeletal muscle oxidative potential and mitochondrial function may reduce afferent chemoreflex. Reduced ventilation, breathing frequency and the resulting reduced dynamic hyperinflation could explain, in part, the reduction in dyspnea [18]. However, there is also an improved symptom tolerance, that is, dyspnea for the same ventilation [19]. It is believed that this increased tolerance of the stimuli associated with exercise-induced symptoms, is leading to reduced perception of dyspnea.

Increase access to pulmonary rehabilitation

Most of the pulmonary rehabilitation programs have been conducted in a hospital setting or health care facility, under direct supervision of a health care professional. They offer close supervision by qualified staff. Poor access to pulmonary rehabilitation is an impediment to the widespread use of this effective intervention, in most countries where it has been studied [20–22]. If we wish to have a significant impact on the health status of patients with COPD, the problem of accessibility needs to be solved. Several strategies can be used to resolve this problem: 1) in-patient hospital-based programs [23], 2) community-based programs [24], and 3) home-based programs [25, 26].

Although quite effective, in-patient hospital-based rehabilitation would be difficult to justify as the first-line of rehabilitation intervention to a third-party payer. Rather, this approach seems particularly tailored to the needs of the most disabled patients. Community-based rehabilitation is often confused with home-based rehabilitation. A major difference is that community-based rehabilitation involves direct patient supervision and regular visits with health-care professionals [24, 27, 28]. In fact, it replicates the professional, technical, and financial requirements of hospital-based outpatient rehabilitation at the community level. Home-based rehabilitation implies no direct patient supervision, that is, a training program which is self-monitored.

Home-based pulmonary rehabilitation programs have been proposed as an alternative to outpatient hospital-based programs. Minimal supervision and, consequently, fewer resources would be needed, and more patients could be enrolled. A recent systematic review [29] of currently available randomised clinical trials of home-based pulmonary rehabilitation for COPD patients has shown that home-

based pulmonary rehabilitation is effective and of equivalent benefit to hospital-based programs. Table 1 presents the benefits of home-based pulmonary rehabilitation in comparison to hospital-based programs with respect to health-related quality of life. Although only a few studies have systematically assessed the risk of adverse events with home-based rehabilitation, when reported, most were related to COPD exacerbations and serious adverse events were not related to the study intervention [26].

Self-monitored, home-based pulmonary rehabilitation could be easily implemented in many countries. Table 2 presents an example of an outpatient hospital-based and home-based exercise training, including the similarities and differences between the two programs. The opportunity to offer different pulmonary rehabilitation settings tailored to individual needs should improve accessibility to this intervention. Self-monitored, home-based pulmonary rehabilitation may help expand the recognition, application and accessibility of pulmonary rehabilitation for patients with COPD. Although no economic analysis has been done yet, we have no reason to believe that home-based rehabilitation would be more expensive than outpatient hospital-based programs.

Maintaining exercise health behaviour: a real challenge

The most important aim of pulmonary rehabilitation should be to maintain physical activity and exercise after the initial phase of training. Disability cannot be reduced to a single component. Looking at the biological and physiological aspects as the only explanatory factors to functional and health status improvement after exercise rehabilitation is simplistic and unrealistic. We must have a coherent view of different perspectives of health, including biological, individual and social perspectives. This is particularly important when addressing the issue of exercise maintenance and the long term benefits.

Due to the decline in exercise adherence following rehabilitation, studies have failed to show long-term benefits in exercise capacity or quality of life [30, 31]. Exercise behaviour is a complex and multi-faceted health behaviour,

Table 1
Health-related quality of life of home-based pulmonary rehabilitation in comparison to hospital-based programs. Adapted from [29].

Study	HRQL	HRQL – at the end of the rehabilitation program			HRQL – follow-up		
		Within-group diff. from baseline		Between-group diff.	Within-group diff. from baseline		Between-group diff.
		HBG	OBG	HBG-OBG	HBG	OBG	HBG-OBG
Güell et al. (2008) [43]	CRQ	n = 23	n = 28		n = 20	n = 23	
	Dyspnea	0.56*	0.87*	–0.21 (NS)	0.55*	0.66*	–0.13 (NS)
	Mastery	NS	0.6*	–0.42 (NS)	NS	0.6*	–0.50 (NS)
	Fatigue	NS	0.56*	–0.19 (NS)	NS	0.57*	–0.32 (NS)
	Emotion	NS	0.76*	–0.58**	NS	0.75*	–0.73**
Maltais et al. (2008) [26]	CRQ	n = 119	n = 114		n = 107	n = 109	
	Dyspnea	0.82***	0.78***	0.05 (NS)	0.62***	0.46***	0.16 (NS)
	Mastery	0.49***	0.51***	–0.02 (NS)	0.39***	0.30***	0.09 (NS)
	Fatigue	0.36***	0.46***	–0.10 (NS)	0.25**	0.10 (NS)	0.18 (NS)
	Emotion	0.35***	0.38***	–0.03 (NS)	0.28***	0.20**	0.08 (NS)
Puente-Maestu et al. (2000) [15]	CRQ	n = 20	n = 21				
	Dyspnea	0.8**	0.72**	NS			
	Mastery	1.35**	1.75**	NS			
	Fatigue	0.7**	0.82**	NS			
	Emotion	0.67**	0.43**	NS			

CRQ: Chronic Respiratory Questionnaire; HBG: Home-based group; HRQL: Heath-related quality of life;
NA: non available or not provided; NS: not significant; OBG: Out-patient based group.
* p <0.05, ** p ≤0.01, *** p ≤0.001

Table 2
Exercise training program, hospital versus homebased pulmonary rehabilitation. From [26].)

		Hospital based	Home based
	Duration of training program	8–12 weeks	8–12 weeks
Aerobic training (bicycle, treadmil)*, **	Duration	25–30 minutes	30–45 minutes
	Sessions	≥3 times/week	≥3 times/week
	Target intensity	80% peak works	60% peak works
Strength training	Duration	30 minutes	30 minutes
	Sessions	3 times/week	3 times/week
	Training	1 set of 10 repetitions per exercise (max. 3 sets)	1 set of 10 repetitions per exercise (max. 3 sets)
	Supervision	Direct supervision and ratio 4–6 patients/trainer	Direct supervision 1–2 sessions and then weekly telephone follow-up
	* The exercise therapist has to instruct the patient to adjust the training intensity according to the level of dyspnea (maximum Borg scale ≥7), dizziness, or unusual chest pain or leg discomfort. ** Use of oxygen if desaturation (SpO2 <88%)		

and is influenced by clinical and psychosocial characteristics. Consistent with Bandura's social cognitive model of human behaviour, self-efficacy has been associated with enhanced exercise performance in a pulmonary rehabilitation context [3, 32].

However, exercise behaviour is also influenced by other factors such as outcome expectancies [33] and the perceived barriers that must be overcome to exercise regularly [34]. Barriers can include psychological and physical factors (internal barriers), and environmental and social factors (external barriers). Clinical experience suggests that barriers influence short- and long-term exercise adherence in COPD patients. Identifying individuals at risk of difficulty engaging in physical activity, and implementing appropriate interventions during and after the rehabilitation program, may promote better long-term physical activity maintenance.

There are factors that might be important to identify as they have negative effects (external and internal barriers, disease severity and exacerbations) on adherence to exercise maintenance. This may represent important areas for enhancing long-term exercise involvement among COPD patients although it needs to be evaluated in future work.

Self-management to help in maintaining exercise health behaviour

If we aim to maintain exercise health behaviour, it is important that pulmonary rehabilitation is not isolated. A shift of the paradigm from acute to chronic care approach is required if we want COPD patients to adopt and maintain new self-help behaviour. We need a dependable system of coordinated health care interventions and communication, and components that include self-management support. Self-management is defined as a support program that involves collaboratively helping patients acquire the skills needed to carry out disease specific medical regimens, guiding changes in health behaviour to help adjust their roles for optimal function, control of their disease and improve their well-being. Self-management should be an integrated part of pulmonary rehabilitation and remain long after the pulmonary rehabilitation is completed. This will allow a shift from management by health care providers, to management by patients themselves.

Pulmonary rehabilitation represents a window of opportunity to exploit enhancement of patient compliance to medication, and to improve patient self-efficacy in breathing strategies and energy conservation. Table 3 presents specific skills to master, and healthy behaviours to adopt and maintain in COPD self-management, as part of a pulmonary rehabilitation program. However, too often in pulmonary rehabilitation, self-management is all about education rather than ensuring patient behaviour change and maintenance after the exercise training program is completed. Having an assigned case manager would facilitate communication with the team's other health professionals to ensure regular progress and problem assessments, common goal setting, motivation and confidence building, and problem solving support. Evaluating patients' comprehension, attitudes and self-efficacy, skills mastered and healthy behaviours adopted should be done through a continuous process to determine if the pre-established goals and objectives are met. The self-management plan should be revised when goals and objectives are not met.

Self-management interventions have shown positive outcomes for patients with COPD [35, 36]. In the most recent update of the Cochrane review [36], it was demonstrated that self-management programmes reduce the probability of COPD-related hospital admissions. Another systematic review [35] demonstrated a significant reduction in healthcare utilisation (unscheduled/emergency centre visits, number of hospitalisations, and length of hospital stay) in trials that implemented self-management with other components of the chronic care model, compared to trials with self-management alone. However, there is limited research in COPD self-management regarding maintenance of physical activity and/or exercise participation.

Exercise behaviour research occurs, in a large part, from studies not specific to COPD, but to chronic disease populations. In longitudinal studies of the elderly with follow up at or over twelve months [33, 37], exercise self-efficacy or changes in self-efficacy were predictors of exercise adherence. Outcome expectancies, defined as the estimate of expected benefits from regular exercise, were also associated with adherence [33]. Confusion (impaired orientation) and depression were predictors of poor adherence to a home-based strength training program in elderly people [38], but the role of affective factors is still unclear and warrants further study. In a review article [34] of 27 cross-sectional and 14 longitudinal studies of individuals 65 years or older, it was shown that education level and past exercise behavior correlate positively with the performance of regular exercise. Conversely, physical factors of perceived frailty and poor health were the greatest barriers to exercise adoption and maintenance.

The finding of physical factors as a barrier to exercise behaviour change and maintenance is in agreement with a qualitative study conducted in COPD patients by Nault et al. [39]. This qualitative study demonstrated that barriers to lifestyle changes frequently reported by patients were: 1) progression of COPD, and 2) associated co-morbid conditions. In another study, Brooks et al. demonstrated that the most consistently reported reasons for non-adherence were chest infection and disease exacerbation [30]. Most recently, Soicher et al. [40] have shown that past exercise habits, six-minute walk distance and barriers were the variables that most strongly revealed differences between patients who maintain compliance compared to those who were poor compliers or decreased compliance to exercise in the long term. The importance of exercise barriers, observed in this study, points to an area often overlooked in pulmonary rehabilitation.

Therefore, these characteristics are potentially useful for identifying individuals at risk of lower activity levels, targeting maintenance interventions to specific areas that include self-management as part of a continuum of care. Table 4 covers aspects of self-management intervention that are not routinely carried out in current practice of pulmonary rehabilitation. Changing patient behaviour and ensuring maintenance is complex and requires time. Programs targeting behaviour change and maintenance need to be studied in properly designed, randomised, clinical trials.

Continued development of recommendations, and research in this area are clearly needed.

Conclusion

Pulmonary rehabilitation is feasible for most COPD patients and there is evidence of clinical benefits. For most COPD patients, the objective should be to improve functional capacity that can translate into increased daily life activities and improved health-related quality of life. The pulmonary rehabilitation setting seems irrelevant. Home-based pulmonary rehabilitation has been shown to be as effective as hospital-based programs. However, many questions remain un-answered. How do we optimise training benefits and maintenance to prevent functional decline? How do we combine interventions to optimise gains? How do we adapt exercise training modalities to optimise physical benefits and, most importantly, adherence (long term)?

Sustained long-term physical activity remains a challenge for patients with COPD. Physical activity following rehabilitation appears insufficient overall, but there is heterogeneity among COPD patients, with some maintaining activity better than others. By early identification of patients who may have difficulty maintaining exercise and implementing appropriate interventions during and after the rehabilitation program, it may be possible to promote better long-term involvement in physical activity.

This is the pivotal objective of self-management, that is to change and maintain patients' behaviour [41]. The success of a pulmonary rehabilitation program should not only be to increase performance but it should correspond to acquiring key self-management skills and self-health behaviours (adherence to medication, early recognition of

Table 3
Self-management skills and healthy behaviors for COPD self-management.

Healthy Behavior	Self-management skill (strategy)
Live in a smoke free environment	Quit smoking, remain non-smoker and avoid second-hand smoke.
Comply with your medication	Take medication as prescribed on a regular basis and use proper inhalation techniques.
Manage to maintain comfortable breathing	Use according to directives: – the pursed-lip breathing technique – the forward body positions
Conserve your energy	Prioritize your activities, plan your schedule and pace yourself.
Manage your stress and anxiety	Use your relaxation and breathing techniques, try to solve one problem at a time, talk about your problems and do not hesitate to ask for help and maintain a positive attitude.
Prevention and early treatment of COPD exacerbations	Get your flu shot every year and your vaccine for pneumonia. Identify and avoid factors that can worsen your symptoms.
	Use your Plan of Action according to the directives (recognition of symptom deterioration and actions to perform). Contact your resource person when needed.
Maintain an active life style	Maintain physical activities (activities of daily living, walking, climbing stairs, etc.). Exercise regularly (according to a prescribed home exercise program).
Keep a healthy diet	Maintain a healthy weight, eat food high in protein and eat smaller meals more often (5–6 meals/day).
Have good sleep habits	Maintain a routine, avoid heavy meals and stimulants before bedtime and relax befor bedtime.
Maintain a satisfying sex life	Use positions that require less energy. Share your feelings with your partner. Do not limit yourself to intercourse, create a romantic atmosphere. Use your breathing, relaxation and coughing techniques.
Get involved in leisure	Choose leisure activities that you enjoy.
Activities	Choose environments where your symptoms will not be aggravated. Pace yourself through the activities while using your breathing techniques. Respect your strengths and limitations.

Adapted from Bourbeau J, Nault D. Self-management strategies in chronic obstructive pulmonary disease [44].

Table 4
Self-management intervention applied to exercise maintenance in pulmonary rehabilitation.[1]

Process in self-management	Comment/advice according to exercise and physical activity maintenance
Goal selection	Maintain regular physical activity.
Monitoring (information collection and interpretation)	Patient evaluates – detrimental effect of exacerbation on exercise adherence. – barriers to exercise (place, cost, time, schedule, etc).
Decision making and action (based on what patient has been taught and written action plan)	Example of actions when patient has exacerbation: – resume exercise when exacerbation has subsided. – provide booster rehabilitation sessions. Example of actions to overcome barriers: – help patient develop their own strategies to overcome/minimize their effect. – discuss and share success with group. Over time patient will be more precise and more competent in adjusting and performing the appropriate self-help behaviour.
Self-efficacy scale specific to a behavior	A patient will acquire self-efficacy through successful experience, self and peer reinforcement, and successful outcomes. Example: confident: ≥7/10; very confident: ≥9/10.

[1] Health professionals will help patients find and evaluate strategies. Proper communication with the physician and health professionals is essential as part of self-management.

symptoms and prompt access to early treatment in the event of exacerbations, breathing techniques, exercising) [42]. Pulmonary rehabilitation should not stand alone; the best program is one which can be maintained to translate into a continuous increase in the activities of daily living. Future research should evaluate the effect of self-management interventions combined with pulmonary rehabilitation to improve long-term activity and exercise maintenance.

Funding / potential competing interests

No funding, no competing interests.

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