

There's no place like home: Integrating pulmonary rehabilitation into the home setting

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Abstract

Traditional, outpatient pulmonary rehabilitation provided to stable chronic obstructive pulmonary disease (COPD) patients leads to significant improvements in dyspnea, exercise capacity and health related quality of life. Also, when started during or shortly after a hospitalization for a COPD exacerbation, pulmonary rehabilitation improves these patient-centered outcomes and arguably reduces subsequent health care utilization and mortality. Despite these benefits, the uptake of traditional pulmonary rehabilitation remains disappointingly poor. Home-based pulmonary rehabilitation, a safe and effective alternative to traditional, center-based programs, can broaden access. While proven improvements in dyspnea, exercise capacity and health status justify implementation of home-based pulmonary rehabilitation, it would be helpful to know whether it can also decrease health care utilization and be cost-effective.

Introduction

The optimal treatment of patients with chronic obstructive pulmonary disease (COPD) must blend pharmacologic and non-pharmacologic therapies. Included in the latter is pulmonary rehabilitation, which has high-quality evidence documenting its benefit across multiple outcomes of importance to the patient, including dyspnea, exercise tolerance and health status [1]. A systematic review suggests it also leads to a reduction in health care utilization, especially in the post-hospitalization period of a COPD exacerbation [2], although one large randomized controlled trial of pulmonary rehabilitation notably failed to demonstrate a positive effect in this area [3].

Despite these benefits, pulmonary rehabilitation has been grossly underutilized [4], probably for multiple reasons, including under-recognition of its importance by healthcare professionals and patients, unwillingness of the patient to attend sessions, unavailability of programs in certain geographic areas, and insufficient third-party reimbursement [5]. After hospitalization for an exacerbation, when the need for pulmonary rehabilitation is arguably greatest, attendance at centers is especially problematic [6]. Offering pulmonary rehabilitation in the home or community setting might increase referrals and patient participation, thereby reducing the effect of under-utilization. Adding to this argument, randomized trials comparing center-based to home-based interventions show equivalence across several patient-centered outcome areas, including dyspnea-relief and improvements in health status and exercise capacity [7-8]. The effect of home-based pulmonary rehabilitation in the post-exacerbation period for COPD has not been adequately tested. This discussion amplifies the rationale for research testing of the feasibility, effectiveness, safety, and costs of delivering pulmonary rehabilitation in the home setting of discharged COPD patients.

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The burden of COPD

COPD, including its systemic effects and common comorbidities, imposes a substantial symptomatic and functional burden on the individual patient, including disabling symptoms such as dyspnea, cough and fatigue; exercise intolerance and physical inactivity; impaired health and functional status; and psychological dysfunction including cognitive impairment, anxiety and depression. Adding to these patient-centered negative outcomes, this preventable disease reached the ignominious level as the third leading cause of death world-wide

and its direct costs have skyrocketed, reaching \$32 billion in the United States and € 38.6 billion in the European Union [9].

Exacerbations add further to the burden of COPD, resulting in severe and relatively prolonged deterioration in symptoms, functional and health status [10-14], increased mortality risk [15-16], and increased subsequent health care utilization. In an analysis of Medicare claims data in the United States, including COPD patients, approximately one-fifth of Medicare beneficiaries were re-hospitalized within 30 days and 34% were re-hospitalized within 90 days of the original discharge date [17]. There are undoubtedly many reasons for this increased health care utilization, including the underlying severity of the respiratory disease and co-morbidities, the fact that exacerbated and vulnerable COPD patients are discharged home early on in the course of the exacerbation [18], temporal clustering of exacerbations, inadequate self management skills, insufficient infrastructure support to the transition from hospital to home [19], and often inadequate and inefficient resources to manage patients after discharge [20]. These deficiencies are not easily corrected.

Pulmonary rehabilitation, collaborative self-management and integrated care

The 2013 Statement on Pulmonary Rehabilitation from the American Thoracic Society and European Respiratory Society defines this intervention as “... 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 of health-enhancing behaviors” [1]. Exercise training along with education and behavior change therapies, aimed at improving self-efficacy and provided by an interdisciplinary team, are central features of pulmonary rehabilitation.

Despite having no direct effect on lung function in COPD, pulmonary rehabilitation typically leads to clinically-meaningful improvements in exercise tolerance, dyspnea, functional and health status [21], although these beneficial effects may decrease in the months-years following participation in the program [22]. One approach to enhancing and sustaining the benefits realized from pulmonary rehabilitation is a focus on behavior change, which is a central feature of collaborative self management education. Self-management in this context is patient-centered education aimed at teaching skills and enforcing behaviors that promote health [23]; these include COPD education, medication management (adherence and inhaler technique), smoking cessation, action plans, promoting exercise and physical activity, proper nutrition, and coping mechanisms [24].

Integrating the management of the COPD patient over the long trajectory of the disease is required for optimal outcomes [25]. In addition to pulmonary rehabilitation and self management, this includes coordination of care among health care providers and settings. This is especially important in the peri-hospitalization period of the COPD exacerbation, which is characterized by high symptom burden, worsening functional status, increased care utilization, and high mortality risk.

Pulmonary rehabilitation settings

Pulmonary rehabilitation as a patient-centered intervention administered by an interdisciplinary team can be provided in either inpatient or outpatient venues. The latter include outpatient, center-based;

outpatient, community-based; and outpatient home-based settings. A survey of pulmonary rehabilitation organizational content involving 430 centers from 40 counties demonstrated that about 90% of programs offered outpatient services, either alone or along with inpatient services [26]. Center- or hospital-based programs are most common. The reasons for this probably reflect availability of personnel and space resources as well as third-party reimbursement payments.

Practically speaking, the severity of the underlying illness (including its systemic effects and comorbid conditions), third-part reimbursement, and availability of programs in the geographic area usually dictate where the intervention is given. It is important to note that regardless of the setting, the best outcomes are largely driven by the skill and commitment of the staff that deliver the program [27].

The rationale for pulmonary rehabilitation in the home

Center (hospital)-based outpatient pulmonary rehabilitation has the professional and physical resources to effectively provide a comprehensive intervention by an interdisciplinary team. Home-based pulmonary rehabilitation does not come close to having these resources, so other factors must provide its *raison d'être*. An editorial by Mike Morgan [27] summarizes of this rationale:

- Only about 15% of those COPD patients with significant disability are ever referred to pulmonary rehabilitation, often owing to lack of local capacity.
- Only about 2/3 of patients referred to traditional centers show up to initiate treatment.
- Only about 70% beginning rehabilitation complete the program. Dropouts from center based programs are probably greater than those from home-based programs.

Home based programs would certainly increase capacity and may increase uptake and completion of pulmonary rehabilitation, and its one-on-one approach may better promote individualization of care. Furthermore, although little evidence-based data are available, maintenance of gains may last longer when the treatment is given in the familiar, home setting [28]. Whether these mostly-theoretical benefits will be actualized in real-life settings remains to be determined. In some health settings, such as in the United States, the case for potential benefits is moot since reimbursement for home visits as part of pulmonary rehabilitation is not provided.

Home-based pulmonary rehabilitation

Home-based pulmonary rehabilitation is perhaps the least common setting for this intervention, as less than 5% of programs offer this option [26]. There is no universal agreement of just what comprises home-based pulmonary rehabilitation, other than that a substantial portion (but not necessarily all) of the intervention is provided in the home setting. Table 1 lists various conceptions of home-based pulmonary rehabilitation, provided for stable COPD patients or in the peri-exacerbation period [3,7,8,28,29-38]. It is important to note that the pulmonary rehabilitation intervention in these studies is exceedingly heterogeneous, underscoring the lack of consensus of what this intervention encompasses.

Two relatively large randomized, controlled trials of home-based versus outpatient, hospital-based pulmonary rehabilitation for clinically stable COPD patients serve to illustrate current concepts of the

Table 1. Home based pulmonary rehabilitation duration, sessions and components.

Author, year	Sessions, duration	Education component	Exercise component	Comments
For clinically-stable COPD patient				
Strijbos, 1996 [30]	Twenty-four sessions, 12 weeks	Information on inhaler use and when to seek medical help; location of education not specified	Supervised by physiotherapist and nurse, individualized, breathing and relaxation, walking, stair climbing, stationary bicycle	Stable COPD, hospitalized for 2 days first
Wedzicha, 1998 [29]	Sixteen sessions, 8 weeks	Sessions of 45-min duration, general education, relaxation techniques, inhaler, nebulizer and oxygen use, nutrition, smoking cessation and psychological problems	Unloaded upper and lower limb training, centering on walking, target 1 h daily	Home-based PR provided to home-bound COPD patients with severe dyspnea, physiotherapist supervision
Hernandez, 2000 [8]	Six sessions per week, 12 weeks; visits to center every 2 weeks for supervision	Not specified	Predominately lower extremity training centering on outdoor walking, individualized, initial goal 70% of maximum	Stable COPD
Boxall, 2005 [4]	Once daily exercise, 12 weeks, average 11 home visits; weekly physiotherapy visits for the first 6 weeks, then fortnightly	Provided by physiotherapy, nursing, and occupational therapy in the home; typically 6 sessions of general education, medication, energy conservation	Graduated walking and arm exercises, each beginning at low intensity and duration and increased according to protocol	Stable COPD referred by hospital-based physicians or physiotherapists
Resqueti, 2007 [35]	Six center-based sessions, approximately 35 home sessions, 9 weeks total	Center-based education before initiating home-based exercise, education centers on exercise techniques	Exercise initiated in centers, followed by 7 weeks in home: leg and arm exercises, inspiratory muscle training, 1.5 hours per session, 5 days per week	Severe to very severe COPD. Initial center-based education and exercise followed by home exercise
Maltais, 2008 [7]	Four center-based educational sessions, 24 home-based exercise sessions, 12 weeks total	8 sessions given in center over initial 4 weeks, centering on self-management	Stationary cycle aerobic training, 3 times weekly for 8 weeks, target intensity was 60% of maximal capacity, target duration 40 min per session, plus strengthening exercises	Stable COPD Exercise specialist initiated exercise in the home, weekly telephone calls
Fernandez, 2009 [6]	Two 1-h sessions in center, 5 home sessions per week, 12 months	Education and exercise education at 2 initial center-based sessions, general education plus training on exercise techniques	Inspiratory muscle training, isotonic upper and lower limb exercises, walking exercises at 90% of 6-min walking speed; Target exercise: 1 hour per session, 5 days per week	Very severe COPD on home oxygen Twice monthly home visits by physiotherapist for 2 months, followed by monthly home visits
Holland, 2017 [8]	One home visit and 7 once-weekly telephone calls, 8 weeks total	Patients given written self-management education pamphlet	30 minutes of aerobic training per session, usually walking exercise, pedometer feedback, sit-to-stand exercises, light weight resistance training	Stable COPD Aimed at utilizing minimal resources; 1 home visit by physiotherapist, weekly telephone calls
In the peri-exacerbation period				
Behnke, 2000 [2]	Ten-day walking training program in the hospital, followed by 3 times a day home walking for 6 months	Not specified	Walking at 125% of best 6-minute treadmill walking distance, breathing exercises	COPD, following hospitalization for exacerbation; walking training started in hospital
Revitt, 2013 [28]	Center-based, 4 weeks; home-based 3 weeks	Provided in the rehabilitation center over the first 4 weeks, 1 h-session	Home component: Daily walking (85% of peak VO ₂) and 3-times weekly resistance training	COPD, following hospitalization for exacerbation Mixed, center-based (4 weeks) and home-based (3 weeks) structured, unsupervised rehabilitation
Greening, 2014 [3]	Variable, in hospital intervention followed by at-home training, 6 weeks total	Provided in the hospital setting and during subsequent telephone calls	Home component: daily walking, neuromuscular electrical stimulation (some patients), supported by telephone calls and motivational interviewing	Early rehabilitation (within 48 h of admission) initiated in the hospital, continued at home
Ko, 2016 [38]	Twelve months total	2 1-hour sessions by a nurse, including general education, self-management, coping skills	Individualized physical training program, given at a center or home, details not specified	COPD, following hospitalization for exacerbation Mixed, center-based and home-based pulmonary rehabilitation; telephone calls every 3 months

home-based intervention. In a study by Maltais and colleagues conducted in Canada [7], the home-based program consisted of: i) A 4-week education program (focusing on self-management) *given in the outpatient, hospital setting*; ii) Aerobic and strength exercises 3 times weekly for 8 weeks in the home; and iii) An unstructured maintenance program. The home exercise centered on training using portable cycle ergometers (supplied to the patients, but taken away after study completion), initiated in the home by an exercise specialist, with a target intensity of 60% maximal work rate, a duration of 40 min, and a frequency of three times weekly, and follow-up with weekly telephone calls. In contrast, in a study by Holland and colleagues conducted in Australia [8], the home-based intervention included one home visit by a physiotherapist to establish exercise goals and supervise the first exercise session, 30-min of twice-weekly walking exercise supported by pedometer feedback, light resistance training, and low intensity calisthenics (such as sit-to-stand exercises). Once-weekly telephone calls from the physiotherapist, using motivational interviewing techniques were given; and selected self-management education and goal setting were incorporated into these weekly discussions. This program lasted 8 weeks.

A review of the home based pulmonary rehabilitation duration, sessions and components is presented in Table 1.

Outcomes from home-based pulmonary rehabilitation

The marked variability in the application of home-based pulmonary rehabilitation (stable COPD *versus* peri-exacerbation); in educational and exercise components (supervised, unsupervised, duration, intensity, *etc.*); hybrid natures of some programs (inpatient or center-based followed by home-based interventions); and experimental design (intervention *versus* usual care or *versus* center-based) make universal efficacy conclusions virtually impossible. One meta-analysis of 18 randomized controlled studies involving 733 patients, from 1991 to 2012 [39], showed positive results (compared to non-intervention control groups), in dyspnea, health-related quality of life, and exercise capacity. No significant changes were seen in maximal exercise workload, hospital admission, cost of care, or mortality. Notably, adverse events were rare and not different between home-based or center-based programs.

It is important to note that the studies in the above-mentioned meta-analysis compared home based treatments with usual care. Two relatively-recent trials of stable COPD patients compared home-based rehabilitation to traditional, center (hospital) – based rehabilitation [8], [24], which is now considered a standard of care [1]. The specifics of the interventions were described previously. Both trials showed equivalent outcomes in the two treatment settings in patient-centered outcomes of dyspnea and exercise tolerance. Health care utilization was not studied in either trial.

Future directions

Based on the preceding discussion, the following areas deserve further development:

- i) A universally-agreed-upon model of what constitutes home-based pulmonary rehabilitation. Using the current definition [1] as the basis; this would include patient selection criteria (who would best be served?), specifics of both the exercise and self-management components, timing and duration, and whether it should be

construed as a stand-alone program or as a bridge to center-based programs. This initiative would require analysis of evidence-based data and considerable expert opinion.

- ii) Randomized, controlled trials evaluating home-based pulmonary rehabilitation in the peri-exacerbation period, including health care utilization as a prominent outcome; the first step would be to compare it with usual care, and then (if successful) with traditional pulmonary rehabilitation.
- iii) An exploration of the potentially longer duration of benefits that may be realized with a home-based intervention as compared to traditional programs where benefits often decline at 1-2 years.

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