Opportunities and Challenges in Expanding Pulmonary Rehabilitation into the Home and Community

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Comprehensive pulmonary rehabilitation has documented positive outcomes for individuals with chronic obstructive pulmonary disease (COPD), including reduction in dyspnea, increase in exercise capacity, and improvement in functional and health status (1). Evidence also suggests that it may reduce healthcare use after COPD exacerbations (2). Since its inception (3–5), pulmonary rehabilitation has gradually evolved to its present form: that of a structured, multicomponent intervention delivered by an interdisciplinary team, addressing the specific health needs of the individual respiratory patient, and typically lasting several weeks (6, 7). Emphasis is placed on augmenting self-efficacy through collaborative self-management training to effect lasting behavior change (8).

Pulmonary rehabilitation typically has little or no direct effect on lung function; rather, it addresses systemic effects of the respiratory disease and secondary morbidities such as ambulatory muscle dysfunction and maladaptive behaviors (9). Supervised exercise training and education (to promote effective self-management) are essential components of pulmonary rehabilitation, as reflected in its consensus definition (6), although one recent Cochrane review required only exercise training for inclusion, without necessarily the education or self-management training components (1).

Pulmonary Rehabilitation

Individual pulmonary rehabilitation programs may differ in their overall organization and content (10). This diversity likely reflects regional variation in healthcare systems, different patient populations, available professional and space resources, and varying approaches. However, on the basis of a 2012–2013 survey of 430 programs in 40 countries (the majority of respondents being in Europe and the Americas) (10), most programs were outpatient: 60.9% offered outpatient treatment only, and 24.7% offered both outpatient and inpatient care; only 4.9% offered treatment in the home or similar settings, with the majority of these combined with more traditional outpatient or inpatient rehabilitation. Most outpatient programs were hospital based, likely reflecting the availability of skilled respiratory health professionals, who traditionally have been located in this setting (11). In general, programs were staffed by 4 or 5 team members (range, 1 to >10), had a duration of 8–12 weeks and consisted of two or three sessions per week. Modalities with >50% use included treadmill walking, stationary cycling, and resistance training exercises; nutritional support; breathing exercises; energy conservation or activities of daily living training; and general and self-management education.

The Problem of Underuse of Pulmonary Rehabilitation

Pulmonary rehabilitation remains grossly underused despite its recommendation by international clinical guidelines (12). An example of this underuse comes from a clinical audit of pulmonary rehabilitation services in England and Wales in 2015 (13). Among an estimated 446,000 patients with COPD who had a Medical Research Council (MRC) dyspnea scale score of 3 or higher, there were only 68,000 referrals (15%) to pulmonary rehabilitation centers. Of those referred, 31% did not attend the initial assessment, 10% did not enroll, and 17% did not complete the intervention. The situation is even more alarming for underreferral to pulmonary rehabilitation after hospitalization for COPD exacerbations, when these individuals, who have markedly impaired quality of life (14) and are at high risk for rehospitalization and mortality (15), stand to benefit substantially (2). In a recent analysis of 223,832 Medicare beneficiaries hospitalized for COPD during 2012, only 1.9% received pulmonary rehabilitation within 6 months of their index hospital admission (16).

There are undoubtedly multiple factors underlying underuse of pulmonary rehabilitation, but two major categories are (1) inadequate awareness and knowledge of pulmonary rehabilitation (among professionals, payers, and patients), leading...
to insufficient referrals; and 2) lack of access to pulmonary rehabilitation for many eligible respiratory patients. These factors were discussed in detail in the 2015 American Thoracic Society/European Respiratory Society policy statement on pulmonary rehabilitation (17).

Patient factors include fear of the intervention, transportation barriers (including distance and mobility issues), timing of the program, insufficient knowledge of pulmonary rehabilitation (including outcome expectations), and social barriers (18–21). Nonreferral of eligible patients by clinicians may reflect inadequate knowledge of the benefits of the intervention or even how to refer patients, actual or anticipated access difficulties, or questioning the need to do more to promote exercise or behavior change (22).

An insufficient number of pulmonary rehabilitation programs is a major issue, as noted by the author of a recent editorial (23). In the United States, just 831 pulmonary rehabilitation centers are available to an estimated 24 million individuals with COPD. This would indicate that there is woeful underprovision. Although not all of these patients may need traditional pulmonary rehabilitation, this number of programs cannot possibly deliver services to more than a tiny fraction of those who would benefit—with a median of 40–75 enrolled patients per program per year (10), the math becomes staggering. Underavailability probably reflects, in part, inadequate reimbursement by insurers or healthcare systems, which jeopardizes the viability of programs. In fact, despite having similar personnel and resource requirements, pulmonary rehabilitation in the United States is reimbursed at about half the rate of cardiac rehabilitation (24). Most centers are urban in location, whereas many eligible individuals live in rural areas; therefore, distance to the center becomes a major availability issue for many patients, and greater distance to the center predicts nonreferral (16) and reduced adherence (25).

Although advocacy efforts to promote the successful and traditional center-based pulmonary rehabilitation model must continue, given the availability, accessibility, and uptake problems mentioned earlier, investigation of alternate forms of program delivery is necessary. The following section discusses these potential alternative forms of program delivery. Although traditional pulmonary rehabilitation is beneficial in many chronic respiratory diseases, most of the evidence in nontraditional settings involves COPD; therefore, we will limit discussion to this disease.

**Definitions and Concepts of Home-based and Community-based Pulmonary Rehabilitation**

In a simplistic fashion, home-based and community-based pulmonary rehabilitation are defined by their respective locations: in the participant’s home for the former and in a community-based setting (not in a hospital and not at home) for the latter (26). However, these categorizations do not reflect the marked heterogeneity of interventions reported in the literature, including type, intensity, and frequency of education and exercise training interventions; staffing; supervision; assessments; and potential for group interaction. It should be noted that, depending on the personnel and equipment used, costs (and therefore cost-effectiveness) could vary considerably.

**Offering Pulmonary Rehabilitation in the Home or Community**

A 2010 systematic review (27) and a 2013 meta-analysis (28) evaluated the effectiveness of home-based pulmonary rehabilitation, comparing it with usual care or center-based interventions in the management of COPD. In both analyses, exercise training was a necessary criterion, but structured education was not, although most studies included some educational content. In general, both demonstrated an advantage of rehabilitation over usual care in dyspnea, exercise performance, and health-related quality of life. Furthermore, the limited number of studies in the systematic review (three at the time) showed data suggesting noninferiority in outcomes of the home-based program compared with the center-based program. What follows is a brief review of selected studies to illustrate current knowledge of potential applications and effectiveness of non–center-based pulmonary rehabilitation interventions.

**Pulmonary Rehabilitation for Patients with Severe COPD**

One potential use of home- or community-based pulmonary rehabilitation would be to provide alternative settings that might be easier for individuals to access than center-based programs. This has been tested in several trials.

In an early study (1998) of pulmonary rehabilitation (29), patients with COPD were randomized to exercise plus education versus education alone. Those with moderate dyspnea (MRC scale score 3 or 4) were given center-based therapy, whereas those with severe dyspnea (MRC scale score 5) were given 8 weeks of pulmonary rehabilitation in the home setting. Although the center-based intervention was effective in improving exercise capacity and health status, the home-based intervention (for severe disease) resulted in no improvement in exercise capacity and minimal or no improvement in health status measures. It is difficult to determine the reason(s) why the latter group did not improve. For instance, were there methodological problems with the study (the education component was not specified, and there may have been a negative selection bias in using an MRC scale score of 5 [“too breathless to leave the house” as a criterion for home-based rehabilitation]), or was it the severity of disease, the intensity of the intervention, or the location of the intervention that was related to noneffectiveness?

A subsequent randomized controlled study (2009) (30) compared home-based pulmonary rehabilitation for outpatients with severe COPD requiring supplemental oxygen with usual care. After two 1-hour sessions at the center, the home-based intervention consisted of a limited number of education sessions, inspiratory muscle training, and upper and lower body exercise training. Exercise training was done for a minimum of 1 hour per day, 5 days per week. In addition, physiotherapists made twice-monthly home visits for 2 months and once-monthly visits for 9 months. Significant within-group improvements at 1 year were noted in functional exercise capacity (mean change was 79 m in 6-min-walk test), exertional dyspnea and leg fatigue during exercise testing, and health-related quality of life in the intervention group but not in the control group.
Between-group statistical comparisons were not provided.

**Home- or Community-based Pulmonary Rehabilitation after Exacerbations of COPD**

Several studies have looked at community- or home-based pulmonary rehabilitation after hospitalization for exacerbations of respiratory disease. Two small randomized trials, one in the home (31) and one in the community (32), demonstrated some improvement in exercise and health-related quality of life compared with usual care. In the former, exercise training was initiated in a hospital-based setting and continued at home, supervised using diaries and occasional visits by investigators. In the latter, a multidisciplinary team provided the intervention in three community settings.

In distinction, one large, two-center trial published in 2014 had negative outcomes (33). In this study, 389 patients with chronic respiratory disease (320 with a primary diagnosis of COPD) were randomized to either 1) pulmonary rehabilitation started in the hospital within 48 hours of admission and continued after discharge for a total of 6 weeks or 2) usual care. Rehabilitation was supervised and provided by a multidisciplinary team while patients remained in the hospital, and then it was home based and not directly supervised after discharge. The primary outcome measure, hospital readmission rate at 12 months, was not different between the groups, and there was no difference in physical performance or health-related quality of life. Uptake of center-based pulmonary rehabilitation (offered at 3 mo after admission) was lower in the intervention group than in the usual care group (14% vs. 22%; \( P = 0.04 \)). The rehabilitation group also had the surprising finding of increased mortality at 12 months compared with the control group (25% vs. 16%; odds ratio, 1.74; \( P = 0.03 \)), a finding that appeared to manifest 6 months after the start of the 6-week intervention and that could not be explained by the investigators. The investigators did comment that this postdischarge study population was, in general, sicker than most patients who were referred to ambulatory pulmonary rehabilitation.

This negative study was understandably of considerable interest in the pulmonary rehabilitation community, prompting nine responses to the journal in which it was published. In one letter (34), responders commented on the fact that almost half the patients in the study self-reported poor or no adherence to several of the treatments, including the 6-week, unsupervised, home-based walking program; daily neuromuscular electrical stimulation; motivational telephone encounters; and a self-management program. In addition, details on the progress of the exercise training were not reported, other than for increased self-reported mean walking time. These issues, combined with the natural recovery of performance and quality of life observed in the usual care group, suggest that the rehabilitation “dose” may have been insufficient in this setting. The respondents astutely raised a question on the need to define just what is necessary for an intervention in this setting to be successful.

**Pulmonary Rehabilitation in the Home or Community as a Potential Substitute for Center-based Therapy**

A 2015 Cochrane review of pulmonary rehabilitation (1) for COPD demonstrated its effectiveness (vs. usual care) in exercise performance and health status. Of interest to our discussion, the reviewers performed a subanalysis of hospital-based and home- or community-based interventions on health status. (Exercise performance was not reported in this subanalysis.) The reviewers grouped home-based and community-based pulmonary rehabilitation for their subanalysis. Forty-one of the pulmonary rehabilitation programs were hospital based (inpatient or outpatient), and 23 were home or community based. Although this was not a head-to-head comparison of the effectiveness of the interventions in these two settings, changes in the four Chronic Respiratory Questionnaire (CRQ) domains of health status were numerically larger (i.e., improved) in hospital-based programs than in home- or center-based programs, but this difference was not present for the St. George’s Respiratory Questionnaire scores assessing health status. The reasons for this discrepancy are not clear. Of note, a number of the community programs included in this analysis implemented exercise training of low frequency or intensity, which may have affected outcomes.

A more recent meta-analysis incorporated in Australian and New Zealand clinical practice pulmonary rehabilitation guidelines (26) evaluated the effectiveness of home- and community-based interventions. Home-based pulmonary rehabilitation improved patient-centered outcomes compared with usual care; these outcomes were also comparable to center-based therapy in a separate analysis, when exercise training of equivalent frequency and intensity was delivered. Community-based rehabilitation was superior to usual care, but a comparison with center-based programs was not made.

A randomized controlled trial conducted in the United Kingdom compared community-based with hospital-based pulmonary rehabilitation (35). Remote sites included church halls and one leisure center, chosen to enhance access. A team provided a core education program, and physiotherapists supervised the intervention. In essence, the only difference in the approaches was the physical setting, and (perhaps understandably) their outcomes were similar.

Using traditional, center-based pulmonary rehabilitation as the gold standard of care for COPD, three equivalence trials conducted in Canada (36), Australia (37), and England (38), respectively, compared the effectiveness of home-based pulmonary rehabilitation with center-based therapy. In all three trials, the exercise programs were structured on the basis of exercise principles established in pulmonary rehabilitation, but they included virtually no face-to-face supervision at home. In contrast to earlier studies of home-based pulmonary rehabilitation, which involved frequent home visits (29), contact with health professionals occurred via infrequent visits and regular telephone calls. Reducing costs of delivery, these programs contrast with traditional center-based programs that use direct supervision and frequent in-person contact between participants and pulmonary rehabilitation providers.

In the Canadian study (36), the home-based intervention involved aerobic and strength exercises three times weekly for 8 weeks. Aerobic training was performed using portable cycle ergometers (supplied by investigators) and was initiated in the home by exercise specialists, with the following parameters: a projected target intensity of 60% of maximal work rate, duration of 40 minutes, and frequency of
three times weekly. Of note, the home-based exercise commenced after attendance at a 4-week center-based education program. In the Australian study (37), the 8-week home-based intervention included one physiotherapist home visit to establish exercise goals and supervise the first exercise session, consisting of walking exercise supported by pedometer feedback and light resistance training using objects found in the home (e.g., sit-to-stand exercises). Patients received highly structured weekly telephone calls that incorporated self-management education, and goal setting was incorporated into these weekly discussions. In the study in England (38), patients were given one introductory session (in the hospital center) with instructions on the exercise program from a professional and supported by a manual designed to facilitate the exercise (39). The home exercise, as was the center-based exercise, was progressive and based on daily walking, with parameters set by shuttle walk test performance at the initial visit, and the program was supported by two highly structured phone calls from trained healthcare professionals.

In all three equivalence studies, completion rates favored the home-based program. No program-related serious adverse events were detected. All studies demonstrated improvements in health-related quality of life and exercise performance over baseline. Two of the three studies showed noninferiority compared with center-based rehabilitation in their respective primary outcomes: CRQ dyspnea and 6-minute-walk distance, respectively (36, 37). In the third study, noninferiority in the primary outcome could not be established, because CRQ dyspnea (self-report) improvement favored the center-based group (38).

More recently, we have observed the development and testing of technology-based alternatives; these have the potential to be attractive to participants, and they offer widespread access to a standardized package of care that can be time and location independent. An example of this use of technology is a parallel-group, noninferiority trial comparing hospital-based with community-based pulmonary rehabilitation in Alberta, Canada, where geography and rurality can be issues (40). Telehealth was used to provide education, and patients exercised at their satellite center under direct supervision. The two approaches were equivalent in quality of life and exercise capacity outcomes.

Components of pulmonary rehabilitation can be personalized with remote face-to-face video conferencing whereby a healthcare professional can connect with one or a small group of individuals exercising in the home. These interventions may remain time constrained, so it would be attractive to consider comprehensive interventions that do not necessarily require a fixed time commitment from either the participant or the healthcare professional. There has been a modest exploration of this type of technology, with encouraging results (41, 42). It is almost inevitable that globally there will be a plethora of digital interventions made accessible to individuals with COPD.

Moving Forward

Despite the proven effectiveness of pulmonary rehabilitation across important outcome areas, it currently is not, and effectively cannot, be provided to all those who would potentially benefit from it. Accordingly, initiative must be taken to fix this disparity. The pulmonary rehabilitation community must continue to advocate for this beneficial and cost-effective intervention (43, 44). More research into increasing patient uptake is needed. In the meantime, referrals must be promoted through educating patients, healthcare providers, and payers on the effectiveness of the intervention.

Adding to these approaches, and the focus of this discussion, is the need for conceptualizing, developing, and testing alternative delivery methods to improve availability and accessibility while maintaining effectiveness. Although scientific evidence fully supports standard, center-based, directly supervised pulmonary rehabilitation as the gold standard, recent trials outlined earlier provide supportive evidence for its extension to the home and/or community settings. On the basis of the amount of information already at hand, there does not appear to be a safety issue with pulmonary rehabilitation in the home or community, although more research is needed, especially if the models include patients with advanced disease, non-COPD diagnoses, and prominent comorbidities. Because pulmonary rehabilitation, as reflected in its consensus definition, is an individualized intervention, assigning the right intervention to the right patient in the right setting is an important consideration. For example, it is likely that individuals with advanced respiratory disease, multiple comorbidities, complex treatment needs, and substantial functional limitation may be better served in a center-based program. Alternatively, those with less severe disease or with time or employment constraints might benefit from the flexibility of a nontraditional program. Even if alternative programs become widespread and prove beneficial, more research would be needed to better determine optimal referral and to assist patients to select the model that is most likely to be effective in their individual circumstances.

A concern with more widespread use of non–center-based programs would be potential cost-effectiveness issues, especially if the model involved sending a team of professionals into a one-to-one home setting. This might be mitigated somewhat if the intervention were given by the team to a group of patients in a community setting. In addition, as described earlier, the more widespread use of telemedicine should improve efficiency, although its benefits are not consistent (45, 46).

However, one-to-one telemedicine might negate the potentially beneficial effects of group dynamics found in center-based programs.

Perhaps a more significant challenge to the widespread use of offering pulmonary rehabilitation outside of traditional centers is the problem of ensuring just what is being delivered and performed without face-to-face supervision. This raises concerns regarding potentially diluting pulmonary rehabilitation to the point that it becomes ineffective. These concerns include 1) risking insufficient education and self-management training and 2) mislabeling suboptimal exercise programs as pulmonary rehabilitation. The former is a distinct possibility with innovative programs that do not provide access to a multidisciplinary team and potentially have less one-to-one time with the patient. The latter would include administering exercise interventions with intensity insufficient to achieve a physiologic training effect.

These legitimate concerns should not lead to limiting treatment to only center-based pulmonary rehabilitation for all
individuals. The need for extending it to a wider population is too urgent. Rather, clinical efforts need to be fostered with the scientific data at hand, and good-quality research in this area needs to be promoted. Implementation of new models should be underpinned by robust quality assurance processes and rigorous evaluation of outcomes at the levels of both the individual patient and the program. There is now an urgent need to define quality standards that are relevant to these new models, because they are already starting to appear in clinical practice. The training needs of practitioners should also be considered: New models may require that health professionals acquire additional skills, including behavior change techniques and the use of new technologies.

Science and clinical practice must move forward with innovative ideas and discoveries. We maintain that the future of pulmonary rehabilitation and the health of patients depend on clinicians’ ability to be pliable and open to newer ways to deliver an evidence-based intervention that clinicians (and their patients) passionately believe in.

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References


