How to adapt the pulmonary rehabilitation programme to patients with chronic respiratory disease other than COPD

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ABSTRACT Dyspnoea, fatigue, reduced exercise tolerance, peripheral muscle dysfunction and mood disorders are common features of many chronic respiratory disorders. Pulmonary rehabilitation successfully treats these manifestations in chronic obstructive pulmonary disease (COPD) and emerging evidence suggests that these benefits could be extended to other chronic respiratory conditions, although adaptations to the standard programme format may be required. Whilst the benefits of exercise training are well established in asthma, pulmonary rehabilitation can also provide evidence-based interventions including breathing techniques and self-management training. In interstitial lung disease, a small number of trials show improved exercise capacity, symptoms and quality of life following pulmonary rehabilitation, which is a positive development for patients who may have few treatment options. In pulmonary arterial hypertension, exercise training is safe and effective if patients are stable on medical therapy and close supervision is provided. Pulmonary rehabilitation for bronchiectasis, including exercise training and airway clearance techniques, improves exercise capacity and quality of life. In nonsmall cell lung cancer, a comprehensive interdisciplinary approach is required to ensure the success of pulmonary rehabilitation following surgery. Pulmonary rehabilitation programmes provide important and underutilised opportunities to improve the integrated care of people with chronic respiratory disorders other than COPD.

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Introduction

Pulmonary rehabilitation is a cornerstone of care for people with chronic obstructive pulmonary disease (COPD), where its role and benefits have been well defined [1]. The success of pulmonary rehabilitation in improving exercise capacity, quality of life and symptoms, whilst reducing hospitalisation [2–6], has led to

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considerable interest in whether such benefits can be extended to other patient groups [7–9]. Individuals with other chronic respiratory diseases often present with a similar constellation of signs and symptoms to those seen in COPD, including dyspnoea, fatigue, reduced exercise tolerance, avoidance of physical activity, anxiety, panic and depression [10–15]. Peripheral muscle dysfunction is also common across many chronic respiratory diseases [13, 16–18]. To date, most pulmonary rehabilitation programmes do enrol a small number of people with chronic respiratory disease other than COPD [19]. However, differences in underlying respiratory pathophysiology, symptomatology and disease course may require modification to the standard rehabilitation format. This review considers the rationale for pulmonary rehabilitation in conditions other than COPD, the evidence underpinning its use, and the programme adaptations that may be required if the benefits of pulmonary rehabilitation are to be experienced by people with other chronic respiratory conditions. A summary of suggested programme adaptations is provided in table 1.

Asthma

People with asthma may experience recurring episodes of wheeze, dyspnoea, chest tightness and coughing [20], between which they may be relatively symptom free. As a result of these episodes, some individuals avoid physical activity and physical exercise due to the fear of triggering symptoms. Adults with asthma have been reported to have lower levels of physical fitness than their peers, as well as increased levels of psychological distress and reduced health-related quality of life (HRQoL) [10, 21, 22]. Chronic corticosteroid use may impact on peripheral muscle function [16]. Some people with asthma will develop fixed airflow obstruction in adulthood, with chronic symptoms similar to those seen in COPD [23].

Exercise training improves physical fitness in people with asthma, without deleterious effects on asthma control [24]. Importantly, more recent randomised controlled trials have also shown positive effects of exercise training on asthma symptoms and quality of life in adults with moderate-to-severe persistent asthma [25, 26]. One of these studies was conducted in a group with a mean age of >65 years [26], similar to the group of older adults with asthma who may be referred to pulmonary rehabilitation. These data strengthen the rationale for inclusion of adults with persistent asthma in pulmonary rehabilitation programmes.

Exercise can be an important trigger of symptoms in some individuals, even when their asthma is otherwise well controlled. Exercise-induced bronchospasm typically occurs 5–10 min after exercise, with symptoms including breathlessness, wheeze, chest tightness or cough. For individuals with exercise-induced bronchospasm, the Global Initiative for Asthma (GINA) guidelines recommend pre-treatment with a

TABLE 1 Special considerations for pulmonary rehabilitation in people with conditions other than chronic obstructive pulmonary disease

	Exercise training	Non-exercise components
Asthma	Assess for exercise-induced bronchospasm If present, pre-medicate with a rapid-acting inhaled β_2-agonist prior to exercise and include a gradual warm-up	Consider breathing retraining techniques with known efficacy in asthma Self-management training includes education, goal setting, a personalised written action plan, self-monitoring of key symptoms and a review of asthma control, treatment and skills
ILD	Ensure supplemental oxygen is available Provide close supervision for individuals with severe disease and marked exercise-induced desaturation In connective tissue-related ILD, consider modifications to avoid joint pain	Consider addressing management of mood disorders, optimising activities of daily living, use of oxygen therapy, lung transplantation and advance care planning Consider linking with support groups and education services appropriate to underlying diagnosis (*e.g.* rheumatoid arthritis)
PAH	A recent history of syncope on exertion is a contraindication to exercise training Monitor PAH-specific symptoms during exercise, *e.g.* palpitations, chest pain, light-headedness and dizziness	Education regarding self-monitoring of PAH symptoms during exercise
Non-CF bronchiectasis	Consider inspiratory muscle training	Initiate or review airway clearance techniques
NSCLC	Duration of pre-operative rehabilitation programme may be shorter than normal so as not to delay cancer treatment Consider alternative forms of exercise training to enhance participation in people undergoing chemotherapy	Ensure a comprehensive interdisciplinary approach Consider nutritional and psychosocial counselling, behavioural change, occupational therapy and progressive relaxation techniques

ILD: interstitial lung disease; PAH: pulmonary arterial hypertension; CF: cystic fibrosis; NSCLC: nonsmall cell lung cancer.

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rapid-acting inhaled β_2-agonist prior to exercise. A leukotriene modifier or cromone are effective alternatives [27]. A gradual warm-up may also minimise exercise-induced bronchospasm [28]. Cardiopulmonary exercise testing may be useful to detect exercise-induced bronchoconstriction prior to commencing an exercise programme [29].

In addition to exercise training, pulmonary rehabilitation can include other evidence-based interventions to enhance quality of life in people with asthma [30]. A systematic review and meta-analysis showed improvements in HRQoL from trials of the Buteyko breathing technique or physiotherapist-led breathing retraining (five trials, effect size 0.35) and yoga breathing (two trials, effect size 0.61) [31]. The follow-up periods for these studies generally did not exceed 6 months, so the longer term benefits are not yet clear. Clinicians who offer breathing exercises to people with asthma in pulmonary rehabilitation must be aware that the physiological rationale and methods for breathing retraining differ substantially from those in COPD. In asthma, breathing retraining typically aims to eliminate over-breathing by developing a slow, shallow, controlled breathing pattern. The breathing strategies used in COPD, such as pursed lip breathing and diaphragmatic breathing [32], have not been tested in people with asthma and should not be routinely offered to this patient group.

Clinicians in pulmonary rehabilitation are well placed to support and enhance self-management for people with asthma, in collaboration with the treating medical team. Whilst improving knowledge alone is not enough to improve outcomes such as hospitalisation and medication use [33], guided self-management is highly effective and considered a cornerstone of modern asthma management [27]. The GINA guidelines state that self-management for asthma requires education, joint goal setting, a personalised written action plan, self-monitoring of key symptoms, and regular review of asthma control, treatment and skills by a healthcare professional [27]. Although there is some overlap with the self-management skills taught to people with COPD in a standard pulmonary rehabilitation programme [34], there are important differences, particularly with regard to symptom monitoring and characteristics of the action plan. For instance, assessment of asthma control in a personal action plan may include frequency of rescue medication use or regular monitoring of peak expiratory flow rate. As a result, pulmonary rehabilitation clinicians should ensure that any self-management training provided meets the guideline requirements for people with asthma [27].

Interstitial lung disease

Interstitial lung diseases (ILDs) are a diverse group of chronic lung conditions that are characterised by scarring of the interstitium and a restrictive ventilatory pattern. A rapid, shallow breathing pattern is common in ILDs, which worsens on exercise and as the disease progresses [35]. Exercise-induced hypoxaemia is also common and may be profound [36]. Pulmonary hypertension is more commonly seen in ILD than in COPD [37] and further impacts on exercise tolerance [38]. Idiopathic pulmonary fibrosis (IPF), the most common of the ILDs, is associated with a poor prognosis and there are few treatment options available [39].

Despite the differences in underlying pathophysiology, many of the important disease manifestations of ILD are similar to those seen in COPD. Exertional dyspnoea may be severe and disabling [17]. Fatigue and exhaustion are also common [40, 41]. Clinically significant depression occurs in approximately 25% of people with IPF [42]. Functional exercise tolerance is often markedly reduced, and those with the greatest impairment in exercise tolerance have the worst quality of life [43]. This constellation of symptoms and impairments is familiar to healthcare professionals in pulmonary rehabilitation.

The evidence base for pulmonary rehabilitation in ILD is small but growing. To date, two randomised controlled trials have evaluated the effects of exercise training in a group with mixed ILDs [44] and IPF only [45]. When evaluated together, these studies show short-term benefits from exercise training for functional exercise tolerance, dyspnoea and quality of life [46]. Although these benefits may be smaller in magnitude than those seen in COPD [47] and may not persist for as long [44], they are clinically significant [48]. In the context of a disease with limited treatment options and where many therapies have toxic side-effects, the potential improvements offered by pulmonary rehabilitation may be highly worthwhile for patients. Current guidelines for the management of IPF make a weak positive recommendation for pulmonary rehabilitation, indicating that it should be used in the majority of patients, but not using pulmonary rehabilitation may be a reasonable choice in a minority [39]. This recommendation acknowledges that uncertainty regarding the duration of benefit means that some patients may reasonably choose not to undertake pulmonary rehabilitation, depending on their personal circumstances.

The optimal exercise prescription for people with ILD is not yet known. Previous studies of pulmonary rehabilitation in ILD have used exercise prescriptions similar to those commonly employed in COPD [44, 45]. However, patients with ILD who have severe or rapidly progressive disease may require modifications to this standard approach. Where adherence to the exercise protocol is limited by distressing dyspnoea, an interval training approach may be useful [49]. Other strategies used to enhance the training effect on peripheral muscle in people with COPD and severe disease, such as neuromuscular electrical stimulation [50], may also have a role in severe ILD, although this has not yet been tested in randomised controlled trials. Supplemental oxygen should be available at all centres providing exercise training for people with ILD, given the prevalence of severe exertional oxyhaemoglobin desaturation and pulmonary hypertension [36, 38]. Close supervision during exercise is required for patients with severe disease, in whom desaturation may be difficult to control even with supplemental oxygen.

As the ILDs are a diverse group of chronic lung conditions, there may be special considerations for rehabilitation in some subgroups. Recent data suggest that in IPF, referral to pulmonary rehabilitation early in the disease course is required to attain maximum benefits, whereas those with other types of ILDs may attain benefits regardless of disease severity [51]. However, other authors have not found such an effect [52]. Given the progressive nature of IPF, some patients may be listed for lung transplantation. In this setting clinicians should consider how to provide ongoing support for exercise whilst on the waiting list. For patients with connective tissue-related ILD, joint pathology and pain are important disease manifestations [53] that should be considered when establishing an exercise programme. It is possible that a water-based exercise programme may be better suited than land-based training in some of these individuals in order to minimise joint loading, similar to that found effective in COPD [2].

Disease education has been documented as an unmet need for people with IPF [54]. Many of the standard, non-exercise components of pulmonary rehabilitation will be useful for people with ILD, such as advance care planning, optimising activities of daily living and management of mood disorders [1]. However, some elements of the COPD self-management programme will not be appropriate, such as revision of inhaler technique, breathing exercises designed for obstructive lung diseases (*e.g.* pursed lip breathing) and COPD action plans. In some circumstances it may be appropriate to link patients with support groups and education services appropriate to their underlying diagnosis, such as for patients with rheumatoid arthritis.

Pulmonary arterial hypertension

Pulmonary arterial hypertension (PAH) is a syndrome resulting from restricted flow through the pulmonary arterial circulation, leading to increased pulmonary vascular resistance and, ultimately, right-sided heart failure. An imbalance in the vasoconstrictor/vasodilator milieu of the pulmonary arteries and also an imbalance of proliferation and apoptosis serve as the basis for current medical therapies [55, 56]. Idiopathic PAH (IPAH) is the most commonly described variant of the disease. A high pulmonary vascular resistance and right ventricular dysfunction impair stroke volume, thereby limiting oxygen supply to the skeletal muscles. This results in lactic acidosis at low work rates and impaired functional capacity [57, 58]. Whilst PAH-specific therapies allow many patients to achieve clinical stability and prolong life, many continue to experience persistent disability, limited ability to engage in physical activities and poor HRQoL [12, 59]. There is also increasing evidence of peripheral muscle dysfunction in people with PAH, which may contribute to ongoing reductions in exercise capacity [18].

People with PAH have often been advised to limit their participation in exercise and strenuous activities due to concerns over precipitous increases in the pulmonary pressures and the possibility of right-sided heart-failure and sudden death [59]. However, recent studies have shown clinically important benefits of exercise training in people with PAH, without evidence of disease progression. In one of the first randomised trials on exercise training in PAH, Mereles *et al.* [60] reported significant improvements in exercise capacity and HRQoL following 15 weeks of daily, low-intensity endurance and strength exercises, with the first 3 weeks of the programme performed in the inpatient setting. More recently, similar benefits have been shown in trials conducted entirely in the outpatient setting [61–63]. The improvements in exercise capacity were accompanied by structural changes of the quadriceps measured by increased capillarisation and oxidative enzyme activity [61].

Whilst exercise training appears to have clinically important benefits, a recent large study has reported that it was associated with adverse events in 13% of 183 patients with a variety of causes of pulmonary hypertension, including IPAH [9]. Whilst no serious events occurred, a number of individuals experienced syncope and pre-syncope during training. This underscores the importance of appropriate symptom monitoring during exercise training. People with PAH may also report palpitations, chest pain, light headedness or dizziness during exercise, often with little warning. As such symptoms may not be detected by standard symptom monitoring scales used during pulmonary rehabilitation [34], clinicians should closely monitor people with PAH during exercise and should provide detailed education regarding symptoms that should be avoided.

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A combination of endurance and resistance exercise is safe and effective for people with PAH [50–54]. Early trials of exercise training for people with PAH used low-to-moderate intensity exercise prescriptions, such as limiting maximum heart rates during exercise to <120 beats per min [60, 61], using interval training [60, 63] or delaying resistance exercise until later in the programme [63]. However, a more recent randomised controlled trial has shown that treadmill training at 70–80% of heart rate reserve was well tolerated in female patients, mainly New York Heart Association (NYHA) class II and III, resulting in improved exercise tolerance and HRQoL [9]. Therefore, it may be possible for selected people with moderate PAH to train at intensities similar to other patients in pulmonary rehabilitation; however, more data are needed in this area.

To date, exercise training trials in PAH have only included participants who are stable on optimal medical therapies. A recent history of syncope on exertion is a contraindication to exercise training [60, 62]. The majority of trial participants have been in World Health Organization/NYHA classes II and III and the study findings should be primarily considered applicable to this group. Several studies have excluded participants in class IV [62–64], although a recent non-randomised study has also reported improvements in these severely affected patients [9]. It is likely that many patients in class IV will require significant reductions in the intensity of the exercise prescription, for both safety and tolerance. The benefits of exercise training do not appear to be dependent on the underlying reason for pulmonary hypertension, with benefits documented in IPAH, chronic thromboembolic pulmonary hypertension, pulmonary hypertension related to respiratory disease and pulmonary hypertension related to left heart failure [9].

In summary, there is emerging evidence that pulmonary rehabilitation and exercise training have clinically significant benefits in patients with PAH. As pulmonary rehabilitation programmes provide close supervision, individual titration and monitoring of exercise, it is an ideal setting for people with PAH to undertake exercise training. Only patients who are stable on optimal medical therapy should be considered for an exercise programme. Because clinically important symptoms differ in PAH compared to other patients in pulmonary rehabilitation and the ideal exercise prescription is unknown, care should be taken to provide an individually targeted and carefully monitored exercise prescription.

Non-cystic fibrosis bronchiectasis

Bronchiectasis is pathologically defined as permanent dilatation of one or more bronchi, secondary to bronchial inflammation and infection. The majority of the patients suffer from idiopathic bronchiectasis [65]. Predominant symptoms include cough with sputum production, dyspnoea and fatigue, followed by reduced exercise tolerance and decreased HRQoL [66–68]. Decreased peripheral muscle strength and endurance have also been found [68]. Many patients experience recurrent exacerbations, with more frequent exacerbations predicting a poorer prognosis [66, 69].

International guidelines recommend the inclusion of people with bronchiectasis in pulmonary rehabilitation to improve physical capacity and HRQoL [34]. However, there are only two randomised controlled trials that have investigated the effect of pulmonary rehabilitation in patients with non-cystic fibrosis bronchiectasis. Both these trials tested interventions that were different to the traditional pulmonary rehabilitation model. In the first reported randomised controlled trial of pulmonary rehabilitation for bronchiectasis, 32 individuals were randomised to receive an 8-week pulmonary rehabilitation programme consisting of endurance exercise training, with or without inspiratory muscle training, or no exercise [70]. There were positive effects on exercise capacity in both exercise groups, but intriguingly, only the group that performed inspiratory muscle training improved their HRQoL. The inspiratory muscle training group also maintained the improved exercise capacity at a 3-month follow-up, which the exercise-only group did not [70]. In a randomised controlled pilot study on 30 patients, the effect of 8 weeks of pulmonary rehabilitation and airway clearance techniques (using oscillatory positive expiratory pressure) was compared to airway clearance techniques alone. They found that addition of pulmonary rehabilitation, including two supervised and one home-based exercise session per week consisting of endurance and strength training, improved exercise capacity and HRQoL more than airway clearance alone [71]. To date, there have been no trials that have reported the effects of pulmonary rehabilitation on exacerbations or hospitalisations in bronchiectasis.

Whilst these results suggest a role for exercise training in people with bronchiectasis, the other components of pulmonary rehabilitation remain to be defined. Although inspiratory muscle training is not a routine component of pulmonary rehabilitation for COPD [1], it may be more useful in bronchiectasis, although the rationale for its use needs further clarification. Airway clearance techniques alone have positive effects on sputum expectoration, some measures of lung function and HRQoL in people with bronchiectasis [72]. A pulmonary rehabilitation programme may provide an ideal opportunity to initiate or optimise airway clearance for people with bronchiectasis, with regular monitoring and technique review.

The available evidence indicates that exercise training is useful in patients with bronchiectasis to improve exercise capacity and HRQoL. Further studies are needed to find out how the traditional pulmonary rehabilitation programmes should be optimised for people with bronchiectasis and whether pulmonary rehabilitation can impact on longer term outcomes.

Nonsmall cell lung cancer

Lung cancer is one of the most common cancers worldwide, and is mostly caused by tobacco smoking [73]. It is generally divided into nonsmall cell lung cancer (NSCLC) and small cell lung cancer, with NSCLC representing 85–90% of all cases [74]. Treatment of lung cancer (*i.e.* surgery, radiotherapy and/or chemotherapy) depends on disease stage, but also on the presence of comorbidities, functional performance, quality of life and peak aerobic capacity [75–77]. Despite many aggressive treatment strategies, it remains the most common cause of cancer-related death [78].

Cancer-related symptoms of dyspnoea and fatigue probably reduce daily physical activity levels in people with NSCLC [79]. Moreover, people with NSCLC suffer from physical deconditioning, including a poor peak aerobic capacity [80], symptoms of depression [81] and a poor quality of life compared with healthy subjects [82]. Pre-operative peak exercise treadmill tests were stopped because of leg discomfort in 70% of the people with NSCLC [83], suggesting that extrapulmonary features, like skeletal muscle dysfunction, may contribute to the poor exercise performance. This hypothesis is strengthened by the fact that pre-operative peak aerobic capacity is not related to spirometric impairments [84], and people with NSCLC have lower quadriceps muscle strength compared to healthy subjects [85].

Patients' daily symptoms of dyspnoea, physical activity levels, peak exercise performance, stair climbing performance and quality of life worsen directly following surgery, and remain impaired for 6 months or longer after surgery [86–91]. The variance in decline in peak aerobic capacity following lobar pulmonary resection can only be explained in part by the change in lung function [92]. Indeed, exercise >6 months after lobectomy is still limited due to leg discomfort in a majority of patients [83]. These findings suggest that lower limb muscle deconditioning is still the underlying cause of exercise intolerance following lung resection. Physical activity levels do not spontaneously recover, remaining lower than pre-operative levels up to 3.5 years after surgical lung resection for NSCLC [90, 91]. Therefore, there is a strong rationale to consider people with NSCLC for referral to pre-operative and post-operative pulmonary rehabilitation programmes.

Data on pre-operative pulmonary rehabilitation in people with NSCLC are sparse. This may partially explain why only a minority of the centres performing thoracic surgery offer pre-operative pulmonary rehabilitation or *vice versa* [93]. Implementing pulmonary rehabilitation in the period between diagnosing NSCLC and its treatment may be challenging, as patients and healthcare professionals are reluctant to delay cancer treatment [94]. MORANO *et al.* [95] found that 4 weeks of pulmonary rehabilitation (including upper limb strength training with free weights, aerobic training in a treadmill, inspiratory muscle training and education) had positive effects on pre-operative functional exercise capacity compared to chest physical therapy in patients awaiting lung cancer resection. Moreover, a lower incidence of post-operative respiratory morbidity and a shorter length of post-operative stay were observed following pre-operative pulmonary rehabilitation [95]. Others have also reported a shorter length of hospital stay following 10 sessions of pre-operative pulmonary rehabilitation (including exercise prescription based on self-efficacy, inspiratory muscle training and the practice of slow breathing) compared to usual care [94]. So, preliminary evidence suggests that pre-operative pulmonary rehabilitation is feasible and beneficial for people with NSCLC, but large, randomised controlled trials are currently lacking.

Grade A evidence on the efficacy of post-operative exercise-based pulmonary rehabilitation in people with NSCLC is also limited [96]. Nevertheless, a subgroup of people with lung cancer may benefit from post-operative pulmonary rehabilitation. To date, physiotherapy services of hospitals mainly focus on reducing or preventing post-operative pulmonary complications in people who undergo surgical resection for lung cancer [97]. Despite numerous reports on the positive effects of post-operative exercise training on cancer-related symptoms, lower limb muscle function, exercise performance and quality of life in people with NSCLC [98–102], referral for post-operative pulmonary rehabilitation is <25% [97]. This may be due to the fact that large, randomised controlled trials and, in turn, robust evidence of the efficacy of pulmonary rehabilitation in people who underwent lung cancer resection are currently lacking [96].

Whether and to what extent chemotherapy may influence the effects of pulmonary rehabilitation remains unclear. Preliminary data suggest that significant improvements in quality of life, exercise performance and fatigue particularly occur among people not receiving chemotherapy [80]. However, this should be confirmed in larger studies. Alternative forms of exercise training may be required to enhance participation in people undergoing chemotherapy. An uncontrolled study showed that people initiating and completing post-operative chemotherapy and/or radiation therapy showed high adherence rates (88%) using the

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Nintendo Wii Fit Plus (Nintendo Co. Ltd, Kyoto, Japan), accompanied by improved cancer-related fatigue scores [103].

People surgically treated for NSCLC may have a prior cancer other than lung cancer, heart disease, osteoporosis, COPD, asthma and/or osteoarthritis [90, 99, 100], which may complicate the process and affect the outcomes of pulmonary rehabilitation. Therefore, post-operative pulmonary rehabilitation should start with a comprehensive assessment in a specialised rehabilitation clinic [104], including screening of comorbidities based on validated objective measurements [105], to establish an individualised pulmonary rehabilitation programme.

Most post-operative exercise training programmes are derived from existing COPD training programmes, or are integrated in a group of people with COPD [99, 106]. Supervised programmes have consisted of cycle ergometry, treadmill walking, weight training, gymnastics or a combination thereof [98, 99]. Training loads were comparable to those of people with COPD, and progressed over time, on the basis of symptom scores for dyspnoea and/or fatigue to maintain the same relative perceived training load during the intervention period [99]. For people who are not able to adhere to these exercise training modalities due to dyspnoea and/or fatigue, t'ai chi [107] or neuromuscular electrostimulation may be a reasonable alternatives [108].

Based on the clinical complexity of people with NSCLC, a comprehensive interdisciplinary approach seems imperative. In addition to exercise training, nutritional and psychosocial counselling, behavioural change, occupational therapy and progressive relaxation techniques should be considered [1, 109]. Indeed, post-operative breathing exercises, including inspiratory muscle training, simple relaxation techniques, activity pacing or psychosocial support under the guidance of physicians and nurse seems to improve lung function and quality of life [110]. CESARIO *et al.* [98] also provided educational sessions focussing on pulmonary pathophysiology, the pharmacology of medications, dietary counselling, relaxation and stress management techniques, energy conservation principles and breathing retraining. Although this approach seems very reasonable, the efficacy of post-operative education remains to be determined.

Conclusion

The current English-language peer-reviewed literature suggests that people with chronic respiratory diseases other than COPD may also benefit from a comprehensive, interdisciplinary pulmonary rehabilitation programme. As well as the documented benefits of pulmonary rehabilitation in asthma, ILD, PAH, non-cystic fibrosis bronchiectasis and lung cancer that are outlined in this review, it may also be useful in other chronic conditions such as cystic fibrosis, neuromuscular disease and individuals following lung transplantation [1]. Existing COPD programmes can easily be adapted to specific needs of these patients, in particular the non-exercising parts. Nevertheless, chest physicians need to become aware of the positive effects of this non-pharmacological intervention to increase referral rates and, in turn, improve the integrated care of people with chronic respiratory diseases.

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