8.03.05	Outpatient Pulmonary Rehabilitation		
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Section:	8.0 Therapy	**Page:**	Page 1 of 34

Policy Statement

I. A single course of pulmonary rehabilitation in the outpatient ambulatory care setting may be considered **medically necessary** for treatment of **either** of the following:
   A. Chronic pulmonary disease for individuals with moderate-to-severe disease who are experiencing disabling symptoms and significantly diminished quality of life despite optimal medical management
   B. As a preoperative conditioning component for those considered appropriate candidates for lung volume reduction surgery (see Blue Shield of California Medical Policy: Lung Volume Reduction Surgery for Severe Emphysema) or for lung transplantation (see Blue Shield of California Medical Policy: Lung and Lobar Lung Transplant

II. Pulmonary rehabilitation programs may be considered **medically necessary** following lung transplantation.

III. Multiple courses of pulmonary rehabilitation are considered **investigational** for **either** of the following:
   A. As maintenance therapy in individuals who initially respond
   B. In individuals who fail to respond, or whose response to an initial rehabilitation program has diminished over time

IV. Pulmonary rehabilitation programs are considered **investigational** for **any** of the following:
   A. Home-based pulmonary rehabilitation programs
   B. Following other types of lung surgery, included but not limited to lung volume reduction surgery and surgical resection of lung cancer
   C. Pulmonary rehabilitation programs in all other situations outside of the medical necessity criteria

NOTE: Refer to Appendix A to see the policy statement changes (if any) from the previous version.

Policy Guidelines

A pulmonary rehabilitation outpatient program is a comprehensive program that generally includes team assessment, individual training, psychosocial intervention, exercise training, and follow-up. The overall length of the program and the total number of visits for each component may vary from program to program.

Team assessment includes input from a physician, respiratory care practitioner, nurse, and psychologist, among others.

Individual training includes breathing retraining, bronchial hygiene, medications, and proper nutrition.

Psychosocial intervention addresses support system and dependency issues.

Exercise training includes strengthening and conditioning, and may include stair climbing, inspiratory muscle training, treadmill walking, cycle training (with or without ergometer), and supported and unsupported arm exercise training. Exercise conditioning is an essential component of pulmonary

rehabilitation. Education in disease management techniques without exercise conditioning does not improve the health outcomes of individuals who have chronic obstructive pulmonary disease.

Follow-up to a comprehensive outpatient pulmonary rehabilitation program may include supervised home exercise conditioning.

Candidates for pulmonary rehabilitation should be medically stable and not limited by another serious or unstable medical condition.

Contraindications to pulmonary rehabilitation include severe psychiatric disturbance (e.g., dementia, organic brain syndrome) and significant or unstable medical conditions (e.g., heart failure, acute cor pulmonale, substance abuse, significant liver dysfunction, metastatic cancer, disabling stroke).

Coding

The following are global HCPCs codes for pulmonary rehabilitation services:

- **G0237**: Therapeutic procedures to increase strength or endurance of respiratory muscles, face-to-face, one-on-one, each 15 minutes (includes monitoring)
- **G0238**: Therapeutic procedures to improve respiratory function, other than described by G0237, one-on-one, face-to-face, per 15 minutes (includes monitoring)
- **G0239**: Therapeutic procedures to improve respiratory function or increase strength or endurance of respiratory muscles, 2 or more individuals (includes monitoring)
- **G0302**: Preoperative pulmonary surgery services for preparation for LVRS, complete course of services, to include a minimum of 16 days of services
- **G0303**: Preoperative pulmonary surgery services for preparation for LVRS, 10 to 15 days of services
- **G0304**: Preoperative pulmonary surgery services for preparation for LVRS, 1 to 9 days of services
- **G0305**: Post discharge pulmonary surgery services after LVRS, minimum of 6 days of services
- **G0424**: Pulmonary rehabilitation, including exercise (includes monitoring), one hour, per session, up to 2 sessions per day
- **S9473**: Pulmonary rehabilitation program, nonphysician provider, per diem

The component services may be reported separately using the following CPT codes:

- **94625**: Physician or other qualified health care professional services for outpatient pulmonary rehabilitation; without continuous oximetry monitoring (per session)
- **94626**: Physician or other qualified health care professional services for outpatient pulmonary rehabilitation; with continuous oximetry monitoring (per session)

Description

Pulmonary rehabilitation (PR) is a multidisciplinary approach to reducing symptoms and improving quality of life in patients with compromised lung function. PR programs generally include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Related Policies

- Heart/Lung Transplant
- Lung and Lobar Lung Transplant
- Lung Volume Reduction Surgery for Severe Emphysema

Benefit Application

Benefit determinations should be based in all cases on the applicable contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

Some state or federal mandates (e.g., Federal Employee Program [FEP]) prohibits plans from denying Food and Drug Administration (FDA)-approved technologies as investigational. In these instances, plans may have to consider the coverage eligibility of FDA-approved technologies on the basis of medical necessity alone.

Regulatory Status

- N/A

Rationale

Background

In 2013, the American Thoracic Society and the European Respiratory Society defined pulmonary rehabilitation (PR) as a "comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies that include, but are not limited to exercise training, education, and behavior change."[1] PR programs are intended to improve patient functioning and quality of life. Most research has focused on patients with chronic obstructive pulmonary disease, although there has been some interest in patients with asthma, cystic fibrosis, or bronchiectasis.

PR is also routinely offered to patients awaiting lung transplantation and lung volume reduction surgery. PR before lung surgery may stabilize or improve patients' exercise tolerance, teach patients techniques that will help them recover after the procedure, and allow health care providers to identify individuals who might be suboptimal surgical candidates due to noncompliance, poor health, or other reasons.

Literature Review

Evidence reviews assess the clinical evidence to determine whether the use of a technology improves the net health outcome. Broadly defined, health outcomes are length of life, quality of life, and ability to function including benefits and harms. Every clinical condition has specific outcomes that are important to patients and to managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of a technology, 2 domains are examined: the relevance and the quality and credibility. To be relevant, studies must represent 1 or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice. The following is a summary of the key literature to date.

Promotion of greater diversity and inclusion in clinical research of historically marginalized groups (e.g., People of Color [African-American, Asian, Black, Latino and Native American]; LGBTQIA (Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual); Women; and People with Disabilities [Physical and Invisible]) allows policy populations to be more reflective of and findings more applicable to our diverse members. While we also strive to use inclusive language related to these groups in our policies, use of gender-specific nouns (e.g., women, men, sisters, etc.) will continue when reflective of language used in publications describing study populations.

This evidence review focuses on comprehensive, multidisciplinary programs that include an exercise component plus other modalities. Where there is a lack of evidence on multidisciplinary pulmonary rehabilitation programs, interventions that are strictly exercise will be considered. In this regard, exercise constitutes the primary intervention that improves outcomes and that, if exercise alone improves outcomes, then it would be expected that exercise plus other modalities would improve outcomes to the same degree or greater.

Chronic Obstructive Pulmonary Disease

Clinical Context and Therapy Purpose

The purpose of a single course of outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without outpatient pulmonary rehabilitation, in patients with moderate-to-severe chronic obstructive pulmonary disease (COPD).

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals with moderate-to-severe COPD.

Interventions

The therapy being considered is a single course of outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators

Comparators of interest include usual care without outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, bronchodilators, and steroid regimens.

Outcomes

The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of outpatient pulmonary rehabilitation as a treatment for moderate-to-severe COPD has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, at least 6 months duration of follow-up is desirable to fully assess outcomes.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

Numerous RCTs and several systematic reviews of RCTs have been published. Most recently, Puhan et al (2016) published a Cochrane review that evaluated pulmonary rehabilitation programs for patients who had an exacerbation of COPD.[2,] To be included, the rehabilitation program had to begin within 3 weeks of initiating exacerbation treatment and had to include physical exercise. Twenty trials (N=1477) met inclusion criteria. Rehabilitation was outpatient in 6 trials, inpatient in 12 trials, both inpatient and outpatient in 1 trial, and home-based in 1 trial. In a pooled analysis of 8 trials, there was a statistically significant reduction in the primary outcome (rate of hospital admissions) for pulmonary rehabilitation compared with usual care (odds ratio [OR]=0.44; 95% confidence interval [CI], 0.21 to 0.91). Several secondary outcomes also favored the pulmonary rehabilitation group. In a pooled analysis of 13 trials, there was a significantly greater improvement from baseline in the 6-minute walk distance (6MWD) in the pulmonary rehabilitation groups (mean difference [MD]=62.4 meters; 95% CI, 38.5 to 86.3). Moreover, a pooled analysis of health-related quality of life found a significantly greater improvement after pulmonary rehabilitation versus control (MD=-7.80; 95% CI, -12.1 to -3.5). However, in a pooled analysis of 6 trials, there was no statistically significant difference between groups in mortality rate (OR =0.68; 95% CI, 0.28 to 1.67). Trials had a mean duration of only 12 months, which may not be long enough to ascertain a difference in mortality rates. Participants in all the studies included in this analysis could not be blinded and this may have introduced bias for outcomes to some degree. Also, some studies did not assess the outcomes of those participants who dropped out of the pulmonary rehabilitation or were lost to follow-up.

McCarthy et al (2015) published a Cochrane review that included RCTs assessing the effect of outpatient or inpatient pulmonary rehabilitation on functional outcomes and/or disease-specific quality of life in patients with COPD.[3,] Pulmonary rehabilitation programs had to be at least 4 weeks in duration and include exercise therapy with or without education and/or psychological support. Sixty-five RCTs (N=3822) met inclusion criteria. Severity of COPD was not specifically addressed by Cochrane reviewers, but article titles suggest a focus on patients with moderate-to-severe COPD. In pooled analyses, there was a statistically significantly greater improvement in all outcomes in pulmonary rehabilitation groups than in usual care groups. Also, between-group differences on key outcomes were clinically significant. For example, on all 4 important domains of the validated Chronic Respiratory Questionnaire (dyspnea, fatigue, emotional function, and mastery) the effect was larger than the accepted minimal clinically important difference of 0.5 units. Also, the between-group difference in maximal exercise capacity exceeded the minimal clinically important difference of 4 watts, and the between-group difference in 6MWD (a mean difference of 43.93 meters) was considered clinically significant.

Rugbjerg et al (2015) published a systematic review that identified 4 RCTs (N=489).[4,] Inspection of the trial designs for the 4 RCTs indicated that none evaluated a comprehensive pulmonary rehabilitation program in patients who met the criteria for mild COPD. Rather than being comprehensive pulmonary rehabilitation programs, all interventions were exercise-based. One intervention included an educational component, and another used a qigong intervention, which included breathing and meditation in addition to exercise. Also, none of the RCTs enrolled a patient population with only mild COPD. Roman et al (2013)[5,] and Gottlieb et al (2011)[6,] included patients with moderate COPD, Liu et al (2012)[7,] included patients with mild-to-moderate COPD, and van Wetering et al (2010)[8,] included patients with moderate-to-severe COPD. Conclusions cannot be drawn about the efficacy of pulmonary rehabilitation in patients with mild COPD from this systematic review.

Tables 1 and 2 summarize the characteristics and results of the Puhan et al (2016)[2,] and McCarthy et al (2015)[3,]studies. The study by Rugbjerg et al (2015)[4,] is not included in Tables 1 and 2 because of study overlap.

Table 1. Systematic Review Characteristics

Study	Dates	Trials	Participants	Intervention	N (Range)	Design	Duration
Puhan (2016)[2,]	Up to Mar 2010*; Mar 2010 to Oct 2015	20	PR patients (N=1477) who met inclusion criteria and had an exacerbation of COPD	Inpatient and outpatient PR	1477 (26-389)	RCT	3-18 mo
McCarthy (2015) [3,]	Up to Jul 2004; Jul 2004 to Mar 2014	65	Patients (N=3822) with mean ages ranging from 31.3 to 74.1 years; in-patient, out-patient, community-based or home-based rehabilitation program of ≥ 4 weeks on continuous oxygen; those with clinical diagnosis of moderate-to-severe COPD and best-recorded FEV_1 <0.7; exercise therapy/intervention (rehabilitation) vs. standard care (control)	Outpatient or inpatient PR ≥ 4 wk that includes exercise therapy +/- education and psychological support (range of PR exercise program = 7 wk to 6 mo)	3822 (12-350)	RCT	≥24 mo

COPD: chronic obstructive pulmonary disease; FEV_1: forced expiratory volume in 1 second; PR: pulmonary rehabilitation; RCT: randomized controlled trial.
*A previous review included information from studies up to this date.

Table 2. Systematic Review Results

Study	Rate of Hospital Readmission	6MWD
Puhan (2016)[2,]	n=810; 8 trials	n=819; 13 trials
N=1477		
PR compared with usual care	Relative effect (95% CI) OR=0.44 (0.21 to 0.91)	Change from baseline, random effects (95% CI) MD=62.38 m (38.45 to 86.31)
McCarthy (2015)[3,]	NR	n=1879; 38 studies
N=3822		
PR compared with usual care	NR	Random, effect size (95% CI) MD=43.93 (32.64 to 55.21)

6MWD: 6-minute walk distance; CI: confidence interval; MD: mean difference; NR: not reported; OR: odds ratio; PR: pulmonary rehabilitation.

Section Summary: Chronic Obstructive Pulmonary Disease

Multiple meta-analyses of RCTs have, for the most part, found improved outcomes (ie, functional ability, quality of life) in patients with moderate-to-severe COPD who have had a comprehensive pulmonary rehabilitation program in the outpatient setting. There is limited evidence on the efficacy of repeated and/or prolonged pulmonary rehabilitation programs, and that evidence is mixed on whether these programs impact additional health outcome benefits.

Idiopathic Pulmonary Fibrosis

Clinical Context and Therapy Purpose

The purpose of a single course of outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without outpatient pulmonary rehabilitation, in patients with idiopathic pulmonary fibrosis.

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is individuals with idiopathic pulmonary fibrosis.

Interventions
The therapy being considered is a single course of outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators
Comparators of interest include usual care without outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medication therapy.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of outpatient pulmonary rehabilitation as a treatment for idiopathic pulmonary fibrosis has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, at least 3 months of follow-up is considered necessary to demonstrate efficacy.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence
Systematic Reviews
Three systematic reviews with meta-analyses have evaluated the use of pulmonary rehabilitation in patients with idiopathic pulmonary fibrosis. A crosswalk of studies included in each review is found in the Appendix (Table A1). Tables 3 and 4 summarize the characteristics and results of the systematic reviews, respectively.

A Cochrane review by Downman et al (2021) evaluated the efficacy and safety of pulmonary rehabilitation in patients with interstitial lung disease in terms of short-term (≤6 months) and long-term (6-11 months) outcomes ; a priori subgroup analyses were performed for participants with idiopathic pulmonary fibrosis.[9,]In patients with idiopathic pulmonary fibrosis, there were significant improvements in 6MWD and Saint George's Respiratory Questionnaire results with pulmonary rehabilitation versus standard treatment in the short-term, but the benefits did not last in the long term (see Table 4). Additionally, pulmonary rehabilitation improved dyspnea scores based on the modified Medical Research Dyspnea Scale (0-4 point scale; 0 indicates no dyspnea) in studies with a follow-up duration of 8 to 12 weeks (MD=-0.41; 95% CI, -0.74 to 0.09). Long-term survival was not improved with pulmonary rehabilitation versus standard treatment in studies with a follow-up of 6 to 11 months (OR=0.32; 95% CI, 0.08 to 1.19).

The meta-analysis by Yu et al (2019) evaluated pulmonary rehabilitation for exercise tolerance and quality of life for patients with idiopathic pulmonary fibrosis.[10,] They analyzed results of 5 RCTs (N=190). In addition to better 6MWD and Saint George's Respiratory Questionnaire results with pulmonary rehabilitation than with standard treatment (see Table 4), forced vital capacity was significantly higher for the pulmonary rehabilitation group (MD=3.69; 95% CI, 0.16 to 7.23; p=.04). However, pulmonary rehabilitation had no significant effect on lung diffusing capacity determined by

the single-breath technique (MD=3.02; 95% CI, -0.38 to 6.42; p=.08). The results of this study suggest the benefits of pulmonary rehabilitation lie in its effect on quality of life, and it may slow the decline of lung function in patients with idiopathic pulmonary fibrosis.

Cheng et al (2018) looked at 4 RCTs and evaluated results in terms of short-term (9-12 weeks) and long-term (6-12 months) outcomes.[11] They found significant benefits in the short term as measured by 6MWD and Saint George's Respiratory Questionnaire, but the benefits did not last in the long term.

Table 3. Systematic Review Characteristics

Study	Dates	Trials	Participants	N (Range)	Design	Duration
Downman (2021)[9]	Through April 2020	21	n=10 studies of patients with mixed ILD etiologies, including IPF; n=9 studies of patients with IPF only; n=5 studies of other ILD etiologies	NR	RCTs	3 wk-4 yr
Yu (2019)[10]	2008-2016	5 (7 articles)	Patients with diagnosed IPF	190 (21-32)	RCTs	10 wk-11 mo
Cheng (2018)[11]	2008-2017	4 (5 articles)	Patients with diagnosed IPF	142 (21-61)	RCTs	9 wk-11 mo

ILD:interstitial lung disease; IPF: idiopathic pulmonary fibrosis; NR: not reported; RCT: randomized controlled trial.

Table 4. Systematic Review Results

Study	6MWD		SGRQ	
Downman (2021)[9]	8 trials	3 trials	6 trials	2 trials
	Short-term (3-12 wk)	Long-term studies (6-11 mo)	Short-term (8 wk-6 mo)	Long-term (6-11 mo)
MD, fixed effects	37.25	1.64	-7.91	-3.45
95% CI	26.16 to 48.33	-24.89 to 28.17	-10.55 to -5.26	-7.43 to 0.52
P-value	<.00001	.9	<.00001	.09
Yu (2019)[10]	5 trials		3 trials	
MD, fixed effects	48.60		-7.87	
95% CI	29.03 to 68.18		-11.44 to -4.30	
P-value	<.001		.031	
Cheng (2018)[11]	4 trials	2 trials	3 trials	2 trials
	Short-term (9-12 wk)	Long-term (6-12 mo)	Short-term (9-12 wk)	Long-term (6-12 mo)
WMD, random effects	38.38	17.02	-8.40	-3.45
95% CI	4.64 to 72.12	-26.87 to 60.81	-11.4 to -5.36	-8.55 to 1.64
P-value	<.05	.43	<.001	.088

6MWD: 6-minute walk distance; CI: confidence interval; MD: mean difference; SGRQ: Saint George's Respiratory Questionnaire (lower score is better); WMD: weighted mean difference.

Section Summary: Idiopathic Pulmonary Fibrosis

Three systematic reviews of RCTs have evaluated pulmonary rehabilitation programs for patients with idiopathic pulmonary fibrosis. Significant differences favoring pulmonary rehabilitation over standard care were seen in 6MWD in the short term. Starting at 3 months post-intervention, outcomes did not differ between groups.

Bronchiectasis

Clinical Context and Therapy Purpose

The purpose of a single course of outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without outpatient pulmonary rehabilitation, in patients with bronchiectasis.

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is individuals with bronchiectasis.

Interventions
The therapy being considered is a single course of outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators
Comparators of interest include usual care without outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medication therapy.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of outpatient pulmonary rehabilitation as a treatment for bronchiectasis has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, 3 to 6 months duration of follow-up is desirable to fully assess outcomes.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence
Systematic Review
Lee et al (2017) published a systematic review of RCTs on pulmonary rehabilitation in patients with non-cystic fibrosis bronchiectasis.[12,] Reviewers identified 4 RCTs. They selected studies of exercise-only interventions as well as exercise combined with education and/or another intervention. The control intervention had to be something other than exercise-based. A pooled analysis of 3 RCTs immediately after an 8-week intervention found significantly greater incremental shuttle walk distance in the intervention compared with the control group (MD=66.6; 95% CI, 51.8 to 81.7). A pooled analysis of 2 trials found significantly greater improvement in the Saint George's Respiratory Questionnaire score postintervention (MD=-4.65; 95% CI, -6.70 to -2.60). There was no significant difference postintervention on the Leicester Cough Questionnaire (total) scores. Reviewers did not conduct meta-analyses beyond the immediate post-intervention period.

Randomized Controlled Trials
Araújo et al (2022) conducted an RCT in Brazil on the effects of pulmonary rehabilitation in individuals with bronchiectasis.[13,]Adults with bronchiectasis confirmed with high-resolution computer tomography were randomized to receive outpatient pulmonary rehabilitation (3 weekly sessions; n=20) or a control intervention consisting of usual care, airway clearance therapy, and breathing exercises (n=21) for 3 months. Physical capacity (measured by 6MWD), dyspnea, quality of life

(measured by the Saint George's Respiratory Questionnaire), fatigue, respiratory muscle strength, and fibrinogen levels were measured before and after treatment. At the end of the 3 month period, the 6MWD increased by a mean of 54 meters in the rehabilitation group versus 12 meters in the control group (p<.01). Additionally, fibrinogen showed a significant reduction in the rehabilitation group compared to control (-92.8 vs. -47.1 mg/dl; p<.01) at 3 months from baseline; quality of life improved at a greater magnitude in the rehabilitation group (-7.5 vs. 3.2; p<.01), which exceeded the minimal clinically important difference of 4 points. This study was limited by its small sample size and short follow-up period.

Section Summary: Bronchiectasis

A systematic review of RCTs on pulmonary rehabilitation for patients with bronchiectasis found that some, but not all, outcomes improved more with pulmonary rehabilitation than with a non-exercise control condition immediately post-intervention. Similarly, an RCT published after the systematic review found that 6MWD and quality of life scores increased with pulmonary rehabilitation compared to a non-exercise control group. Limited observational data would suggest that outcomes in patients with other respiratory conditions may benefit, but likely not as much as COPD patients.

Preoperative Pulmonary Rehabilitation Programs

Clinical Context and Therapy Purpose

The purpose of a single course of preoperative outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without outpatient pulmonary rehabilitation, in patients with scheduled lung surgery for volume reduction, transplantation, or resection.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals with scheduled lung surgery for volume reduction, transplantation, or resection.

Interventions

The therapy being considered is a single course of preoperative outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators

Comparators of interest include usual care without outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medication therapy.

Outcomes

The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of preoperative outpatient pulmonary rehabilitation as a treatment for scheduled lung surgery for volume reduction, transplantation, or resection has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, 3 to 6 months duration follow-up are desirable to assess outcomes.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Lung Volume Reduction Surgery

Pulmonary rehabilitation prior to lung volume reduction surgery represents a distinct subset of patients with COPD, and the National Emphysema Treatment Trial required all candidates to undergo a vigorous course of pulmonary rehabilitation. The final National Emphysema Treatment Trial results supported the treatment effectiveness in a subset of patients with COPD.[14,]

Lung Transplantation

A systematic review of the literature on pulmonary rehabilitation for lung transplant candidates was published by Hoffman et al (2017).[15,] Interventions had to include exercise training but did not have to be part of a comprehensive pulmonary rehabilitation program and could have taken place in the inpatient or outpatient setting. Reviewers identified 6 studies (2 RCTs and 4 case series). Both RCTs evaluated the impact of exercise (not comprehensive pulmonary rehabilitation) on outcomes; additionally, 1 was conducted in the inpatient setting, and it included only 9 patients. Conclusions on the impact of a comprehensive pulmonary rehabilitation program before lung transplantation on health outcomes cannot be drawn from this systematic review.

Lung Cancer Resection

Randomized Controlled Trials

Several small RCTs have evaluated preoperative pulmonary rehabilitation for patients undergoing lung cancer resection. Morano et al (2013) conducted a single-blind study in Brazil.[16,] Patients with non-small-cell lung cancer eligible for lung resection were randomized to 4 weeks of an exercise-only pulmonary rehabilitation program (5 sessions per week) or chest physical therapy; there were 12 patients in each group. All patients in the pulmonary rehabilitation group and 9 of 12 in the chest physical therapy group subsequently underwent surgery (the other 3 patients had inoperable disease). Several short-term postoperative outcomes were assessed. Patients in the pulmonary rehabilitation group spent significantly fewer days in the hospital (mean, 7.8 days) than patients in the chest physical therapy group (mean, 12.2 days; p=.04). Also, patients in the pulmonary rehabilitation group spent fewer days with chest tubes (mean, 4.5 days) than the physical therapy group (mean, 7.4 days; p=.03). The trial did not assess longer-term functional outcomes after surgery. Benzo et al (2011) conducted 2 small exploratory RCTs evaluating pulmonary rehabilitation before lung cancer resection.[17,] Eligibility criteria included having moderate-to-severe COPD and being scheduled for lung cancer resection either by open thoracotomy or by video-assisted thoracoscopy.

The first trial had poor recruitment, enrolling only 9 patients. The second study enrolled 19 patients into a 10-session, preoperative pulmonary rehabilitation program (n=10) or usual care (n=9). The mean number of days in the hospital was 6.3 in the pulmonary rehabilitation group and 11.0 in the control group (p=.058). Three (33%) patients in the pulmonary rehabilitation group and 5 (63%) patients in the control group experienced postoperative pulmonary complications (p=.23). The trial sample size was likely too small to detect statistically or clinically significant differences between groups. Trialists recommended conducting a larger multicenter randomized trial in this population. Tables 5 and 6 summarize the characteristics and results of the RCTs, respectively.

Table 5. Summary of Key RCT Characteristics

Study	Countries	Sites	Dates	Participants	Interventions	
					Active	*Comparator*
Morano (2013)[16,]	Brazil	1	Mar 2008 to Mar 2011	Patients undergoing lung cancer resection and who have non-small cell lung cancer resection by open thoracotomy (or video-assisted); and previous pulmonary disease, interstitial lung disease, or obstructive airway disease, with	PR: Strength/endurance training + education; 5 sessions/wk for 4 wk (20 sessions) (n=12)	CPT breathing exercises + education; 5 sessions/wk for 4 wk (20

Study	Countries	Sites	Dates	Participants	Interventions	
				impaired respiratory function by spirometry (N=24)		sessions) (n=12)
Benzo (2011)[17],	US	2	NR	Patients who require lung cancer resection by open thoracotomy (or video-assisted); moderate-to-severe COPD (N=19)	PR: 10 preoperative PR sessions involving customized protocol with nonstandard components (exercise prescription based on self-efficacy, inspiratory muscle training; slow breathing) (n=10)	Usual care (n=9)

COPD: chronic obstructive pulmonary disease; CPT: chest physical therapy; NR: not reported; PR: pulmonary rehabilitation; RCT: randomized controlled trial.

Table 6. Summary of Key RCT Results

Study	Hospital Stay at 4 Weeks, mean (SD)	ICU Stay (days) at 4 Weeks	Postoperative Hospitalizations
Morano (2013)[16],	N=31 patients at t=0; 24 in analysis; 21 in final analysis	N=31 patients at t=0; 24 in analysis; 21 in final analysis	NR
PR (exercise) n=12	7.8 (4.8)	2 (2-3)[a]	NR
CPT (control) n=9	12.2 (3.6)	2 (2-4.5)[a]	NR
P-value	.04	.20	NR
Benzo (2011)[17],	N=17	N=17	NR
PR arm	6.3 (3.0)	0.6 (1.9)[b]	NR
Usual care	11.0 (6.3)	1.7 (3.1)[b]	NR
P-value	.06	.39	NR

CPT: chest physical therapy; ICU: intensive care unit; NR: not reported; PR: pulmonary rehabilitation; RCT: randomized controlled trial; SD: standard deviation.
[a] Median (25th-75th percentile).
[b] Mean (SD).
The purpose of Tables 7 and 8 is to display notable limitations identified in each study. This information is synthesized as a summary of the body of evidence following each table and provides the conclusions on the sufficiency of evidence supporting the position statement.

Table 7. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Morano (2013)[16],				3. No CONSORT reporting of harms was addressed	1. Short duration of follow-up (4-weeks)
Benzo (2011)[17],	4. Recruitment not met.				

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
[b] Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
[c] Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
[d] Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No

CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
[e] Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 8. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
Morano (2013)[16,]	4. Inadequate control for selection bias: the participants were not evenly randomized			1. High loss to follow-up or missing data	1. Power is not reported	
Benzo (2011)[17,]						

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
b Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
d Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
f Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Observational Study

Bradley et al (2013), in a nonrandomized comparative study, evaluated an outpatient-based pulmonary rehabilitation intervention in 58 lung cancer patients who were candidates for surgery.[18,] This United Kingdom-based study also evaluated a comparison group of 305 patients, also surgical candidates, who received usual care. Patients in the 2 groups were matched by age, lung function, comorbidities, and type of surgery. In a within-group analysis, there was a statistically significant 20-meter improvement in 6MWD in the intervention group before and after participation in a 4-session presurgical pulmonary rehabilitation program. In between-group analyses, there were no statistically significant differences between the intervention and comparisons groups in clinical outcomes such as postoperative pulmonary complications, readmissions, and mortality after surgery.

Section Summary: Preoperative Pulmonary Rehabilitation Programs

The National Emphysema Treatment Trial has recommended administering pulmonary rehabilitation before lung volume reduction surgery, which is considered the standard of care before lung volume reduction surgery and lung transplantation. However, there is a lack of large RCTs comparing pulmonary rehabilitation with no pulmonary rehabilitation for preoperative candidates undergoing lung volume reduction surgery, lung transplantation, or lung cancer resection. The available studies evaluated exercise programs and comprehensive pulmonary rehabilitation. Also, the few small RCTs and observational studies have reported on short-term outcomes and have found inconsistent evidence of benefit even on these outcomes.

Lung Volume Reduction Surgery Postoperative Pulmonary Rehabilitation Programs

Clinical Context and Therapy Purpose

The purpose of a single course of outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without outpatient pulmonary rehabilitation, in patients who have had lung volume reduction surgery.

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is individuals who have had lung volume reduction surgery.

Interventions
The therapy being considered is a single course of outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators
Comparators of interest include usual care without outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medication therapy.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of outpatient pulmonary rehabilitation as a treatment for individuals who have had lung volume rehabilitation surgery has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, 3 to 6 months duration of follow-up is desirable to assess outcomes.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence
No RCTs evaluating comprehensive pulmonary rehabilitation programs after lung volume reduction surgery were identified. Bering et al (2009) reported on a case series involving 49 patients with severe emphysema who participated in a pulmonary rehabilitation program after lung volume reduction surgery.[19,] Patients underwent lung volume reduction surgery at a single center and had not received pulmonary rehabilitation at that institution presurgery. After hospital discharge, patients underwent an outpatient comprehensive pulmonary rehabilitation program for 4 hours a day, 5 days a week for 2 weeks. The program included a multidisciplinary team with a variety of components, including dietary, physical therapy, physical exercise, psychosocial, occupational therapy, and respiratory therapy. The primary outcome was health-related quality of life measured by the 36-Item Short-Form Health Survey. Compared with pre-lung volume reduction surgery scores, significantly better scores were achieved on the Physical Component Summary and Mental Component Summary at both time point 2 (3-6 months post-lung volume reduction surgery) and 3 (12-18 months post-lung volume reduction surgery). Study limitations included no comparison with patients who had lung volume reduction surgery and no pulmonary reduction, and the difficulty disentangling the impact of lung volume reduction surgery from that of pulmonary rehabilitation on outcomes. Moreover, patients had not received pulmonary rehabilitation before lung volume reduction surgery, so the treatment effects of presurgery versus postsurgery lung volume reduction surgery could not be determined.

Section Summary: Lung Volume Reduction Surgery Postoperative Pulmonary Rehabilitation Programs

No comparative studies have evaluated pulmonary rehabilitation programs after lung volume reduction surgery. One case series evaluated a comprehensive pulmonary rehabilitation program after lung volume reduction surgery in 49 patients who had not received preoperative pulmonary rehabilitation. Health-related quality of life was higher at 3 to 6 months and 12 to 18 months post-surgery. The study did not provide data on patients who underwent lung volume reduction surgery and who did not have postoperative pulmonary rehabilitation or on patients who had preoperative pulmonary rehabilitation.

Lung Transplantation Postoperative Pulmonary Rehabilitation Programs

Clinical Context and Therapy Purpose

The purpose of a single course of outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without outpatient pulmonary rehabilitation, in patients who have had lung transplantation.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who have had lung transplantation.

Interventions

The therapy being considered is a single course of outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators

Comparators of interest include usual care without outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medical therapy.

Outcomes

The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of outpatient pulmonary rehabilitation as a treatment for individuals who have had lung transplantation has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, 3 to 6 months duration of follow-up is desirable to assess outcomes.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Systematic Reviews

Exercise training after lung transplantation is reported in the literature but not necessarily provided in comprehensive pulmonary rehabilitation programs. Wickerson et al (2010) published a systematic review of the available literature in which the researcher had evaluated any exercise intervention in conjunction with lung transplantation. Seven studies (RCTs, controlled trials, and prospective cohorts) met the inclusion criteria, including 2 RCTs targeting lumbar bone mineral density. Also included in

the review were uncontrolled studies that reported improvement in functional status as a byproduct of an exercise-program intervention.[20,]

Randomized Controlled Trials

Langer et al (2012) conducted an RCT in the United Kingdom that examined activity-related outcomes in lung transplant recipients after exercise training.[21,] The trial included 40 patients who underwent single- or double-lung transplantation and had an uncomplicated postoperative period. Following hospital discharge, patients were randomized to a supervised exercise program 3 times a week for 3 months (n=21) or to usual care with instructions to exercise (n=19). Patients in both groups had 6 individual counseling sessions in the 6 months post-discharge. Six patients dropped out of the trial, 3 in each group. The primary outcome was daily walking time, assessed by activity monitors. At the end of the 3-month intervention and 1-year post-discharge, mean walking times were significantly longer in the intervention group. At 1 year, the exercise group walked a mean of 85 minutes per day while the control group walked a mean of 54 minutes per day (p=.006). Other outcomes related to daily physical activity were reported as secondary outcomes and some, but not all, significantly favored the intervention group. Mean 6MWD at 1 year was 86% of predicted in the exercise group and 74% of predicted in the control group (p=.002). The trial had a relatively small sample size and may have been underpowered to detect clinically meaningful differences between groups on secondary outcomes.

Fuller et al (2017) published an RCT reporting on the impact of short (7-week) versus long (14-week) rehabilitation programs for patients who underwent lung transplantation.[22,] The primary outcome was change in the 6MWD. Secondary outcomes included the strength of the quadriceps and hamstring muscles (as measured by an isokinetic dynamometer), and quality of life (as measured by the 36-Item Short-Form Health Survey). In both the 7- and 14-week rehabilitation groups, participants increased their 6MWD (mean improvement in 7-week group, 202 meters vs. 14-week group, 149 meters). At 6 months after transplantation, the mean difference between groups was 59.3 meters, favoring the 7-week group (95% CI, 12.9 to 131.6 meters). The increases in strength in quadriceps and hamstring muscles in both groups did not differ statistically. The 36-Item Short-Form Health Survey summary scores of the domains of physical health and mental health both increased over time with no significant difference between groups at any time point.

Tables 9 and 10 summarize the characteristics and results of the RCTs, respectively.

Table 9. Summary of Key RCT Characteristics

Trial	Countries	Sites	Participants	Interventions	
				Active	*Comparator*
Langer (2012)[21,]	UK	1	Patients aged 40-65 y who had undergone a single or bilateral LTX with no postoperative complications (N=40)	Exercise program (3 x/wk for 3 mo) (n=21)	Usual care with added instruction to exercise (n=19)
Fuller (2017)[22,]	US	1	Post-LTX patients aged ≥18 years (N=66; 33 women; mean age=51+/-13 y) who had undergone either single LTX or bilateral LTX	Longer-duration (14-wk) rehabilitation program after LTX	Shorter (7-wk) rehabilitation program after LTX

LTX: lung transplantation; RCT: randomized controlled trial; U.K.: United Kingdom.

Table 10. Summary of Key RCT Results

Study	Daily Walking Time	Mean Improvement in 6MWD From Baseline (SD)	6MWD Difference Between Groups
Langer (2012) [21,]			
N=40	N=34 (final)	NR	NR
3-mo exercise program (baseline/final)=21/18	Mean=85 min/day at 1 y (SD=27 min)	NR	NR
Usual care (baseline/final)=19/16	Mean=54 min/day at 1 y (SD=30 min)	NR	NR

Study	Daily Walking Time	Mean Improvement in 6MWD From Baseline (SD)	6MWD Difference Between Groups
Mean difference	26 min (adjusted)	NR	NR
95% CI	8 to 45	NR	NR
P-value	.0006	NR	NR
Fuller (2017) [22,]			
N=66	NR	N=64 at 6 mo	N=64 at 6 mo
Longer-duration (14 wk) PR program	NR	+149 m (169 m)	NR
Shorter-duration (7 wk) PR program	NR	+202 m (72 m)	NR
P-value	NR	.5	NR
Mean difference	NR	NA	59.3 m favoring 7-wk group
95% CI	NR	NR	12.9 to 131.6

6MWD: 6-minute walk distance; CI: confidence interval; NA: not applicable; NR: not reported; OR: odds ratio; PR: pulmonary rehabilitation; RCT: randomized controlled trial; SD: standard deviation.

The purpose of Tables 11 and 12 is to display notable limitations identified in each study. This information is synthesized as a summary of the body of evidence following each table and provides the conclusions on the sufficiency of evidence supporting the position statement.

Table 11. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Langer (2012)[21,]					
Fuller (2017)[22,]	1. Selection criteria not clear		2. Fitness activity monitor not validated as comparator for this clinical scenario.		

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

[a] Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.

[b] Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.

[c] Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.

[d] Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.

[e] Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 12. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
Langer (2012)[21,]		1. Patients not blinded. Blinding not feasible. Outcome assessment not blinded.				
Fuller (2017)[22,]		1. Patients not blinded. Blinding not feasible. Outcome assessment not blinded.			1,2. Power is affected by small sample size, underpowered to detect	

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
					meaningful differences	

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
[b] Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
[c] Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
[d] Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
[e] Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
[f] Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Case Series

Munro et al (2009) published a case series that evaluated a comprehensive pulmonary rehabilitation program after lung surgery.[23,] The 7-week program, which started 1-month post-surgery, consisted of 1 hour of supervised exercise 3 times a week and a weekly group education session facilitated by a multidisciplinary team (e.g., nurse, dietician, occupational therapist, social worker). Compared with baseline, on program completion, both forced expiratory volume in 1 second and forced vital capacity had improved significantly ($p<.001$). For example, mean forced expiratory volume in 1 second was 71% at 1-month post-surgery, and 81% at 3 months. Similarly, 6MWD improved significantly: mean distance was 451 meters at 1 month and 543 meters at 3 months post-transplant. The study lacked a control group. Hence, the degree of improvement that would have occurred without participation in a pulmonary rehabilitation program is unknown.

Section Summary: Lung Transplantation Postoperative Pulmonary Rehabilitation Programs

A systematic review of exercise training after lung transplantation (not necessarily provided in a comprehensive pulmonary rehabilitation program) identified 7 controlled and uncontrolled studies but did not pool study findings. Neither RCT identified reported functional outcomes, but the uncontrolled studies reported improvements in functional outcomes. An RCT, published after the systematic review, found that patients who had a postsurgical exercise intervention walked more 1-year postdischarge and had a significantly greater 6MWD. The most recent RCT (2017) did not identify a difference in outcomes with longer duration of pulmonary rehabilitation. Findings on other outcomes were mixed. Case series data also support improvement in the 6MWD after postoperative pulmonary rehabilitation.

Lung Cancer Resection Postoperative Pulmonary Rehabilitation Programs

Clinical Context and Therapy Purpose

The purpose of a single course of outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without outpatient pulmonary rehabilitation, in patients who have had lung cancer resection.
The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals who have had lung cancer resection.

Interventions
The therapy being considered is a single course of outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators
Comparators of interest include usual care without outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medical therapy.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of outpatient pulmonary rehabilitation as a treatment for individuals who have had lung cancer resection has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, 3 to 6 months duration of follow-up is desirable to assess outcomes.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence
Randomized Controlled Trials
Stigt et al (2013) published an RCT evaluating a multicomponent postsurgery pulmonary rehabilitation program in patients with resectable lung cancer.[24,] The trial was conducted in the Netherlands. Before thoracotomy, 57 patients were randomized to pulmonary rehabilitation or usual care. The 12-week pulmonary rehabilitation program started 4 weeks after surgery and consisted of exercise training, pain management, and visits with a medical social worker. The trial was terminated early because the institution started offering video-assisted thoracoscopic surgery, at which point few patients chose thoracotomy. Data on 49 patients (pulmonary rehabilitation=23, usual care=26) were analyzed. The primary endpoint was quality of life, as measured by the difference between groups in change in the total St. George's Respiratory Questionnaire score from baseline to 12 months. This difference was 2.71 points, which was not statistically significant (p=.69).

However, 6MWD (a secondary outcome) improved significantly in the pulmonary rehabilitation group versus the usual care group at 3 months. The between-group difference in 6MWD was 94 meters (p=.024). A limitation of this analysis is that only 8 of 23 patients in the pulmonary rehabilitation performed a 6MWD at 3 months; the other 15 patients had dropped out or did not take the test. Eleven of 25 patients in the usual care group performed the 6MWD.

An exercise-only intervention after lung cancer surgery (not comprehensive pulmonary rehabilitation) was evaluated in an RCT published by Edvardsen et al (2015).[25,] This single-blind trial was conducted in Norway and included lung cancer patients at 4 to 6 weeks post-surgery. Sixty-one patients were randomized to an exercise program 3 times a week for 20 weeks or to usual care. The exercise intervention took place at local fitness centers and was supervised by trained personal trainers and physical therapists. A significantly greater improvement was reported for the primary outcome (change in peak oxygen uptake from baseline to the end of the intervention) in the intervention group than in the control group (between-group difference, 0.26 L/min; p=.005) Findings on secondary outcomes were mixed. For example, the between-group difference in forced expiratory volume in 1

second was 0.6% of predicted (95% CI, -4.2% to 5.4%; p=.738) and the difference in stair run was 4.3 steps (95% CI, 1.6 to 7.1 ; p=.002). This trial did not report other functional outcomes (e.g., 6MWD).

Section Summary: Lung Cancer Resection Postoperative Pulmonary Rehabilitation Programs

A single RCT has evaluated a comprehensive pulmonary rehabilitation program in patients who underwent thoracotomy for lung cancer. The trial was terminated early, had a high dropout rate, and reported mixed findings. An exercise-only intervention in patients who had lung cancer surgery had mixed findings and did not evaluate functional outcomes. Current evidence is not sufficiently robust to draw conclusions on the utility of pulmonary rehabilitation programs to those who have had lung resection.

Repeat or Maintenance Outpatient Pulmonary Rehabilitation Programs

Clinical Context and Therapy Purpose

The purpose of repeat or maintenance outpatient pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as usual care without repeat or maintenance outpatient pulmonary rehabilitation, in patients who have had an initial course of pulmonary rehabilitation.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals with lung conditions who have had an initial course of pulmonary rehabilitation.

Interventions

The therapy being considered is repeat or maintenance outpatient pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change. Repeat or maintenance pulmonary rehabilitation programs provide additional rehabilitation services after initial participation in a pulmonary rehabilitation program. Maintenance programs tend to be designed to extend the effects of the initial pulmonary rehabilitation program, and they are open to all patients who successfully completed an initial program.

Comparators

Comparators of interest include usual care without repeat or maintenance outpatient pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medical therapy.

Outcomes

The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating repeat or maintenance outpatient pulmonary rehabilitation as a treatment for individuals who have had an initial course of pulmonary rehabilitation has varying lengths of follow-up. While studies described below all reported at least 1 outcome of interest, 3 to 6 months duration follow-up is desirable to assess outcomes.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Repeat Outpatient Pulmonary Rehabilitation Programs

Repeat pulmonary rehabilitation programs provide additional rehabilitation services after initial participation in a pulmonary rehabilitation program. Repeat programs are generally those that include patients who failed to respond to an initial program or whose response to an initial rehabilitation program diminished over time.

Carr et al (2009) prospectively identified Canadian patients with moderate-to-severe COPD who experienced an acute exacerbation within 12 months of participating in a pulmonary rehabilitation program.[26,] All patients had initially completed a 6-week inpatient program or a 12-week outpatient program. Patients were then randomized to receive 3 weeks of pulmonary rehabilitation therapy or usual care. The repeat pulmonary rehabilitation program consisted of exercise and education; patients could choose inpatient or outpatient versions. Over a mean of 14 ± 11 weeks, 41 patients developed an exacerbation. Seven patients withdrew from the trial, and the remaining 34 were randomized to a repeat pulmonary rehabilitation program within 1 month of the exacerbation (n=17) or to no repeat pulmonary rehabilitation program (n=17). One patient in the intervention group dropped out; of the remaining 33 patients, 25 (76%) experienced an exacerbation of moderate severity; the remaining 8 had severe exacerbations. Nine (56%) of 16 patients in the intervention group chose an inpatient program, and 7 chose an outpatient program. Patients were assessed before the repeat pulmonary rehabilitation program, immediately after (3 weeks later), and again 12 weeks after the beginning of the exacerbation (5 weeks after completing the repeat rehabilitation program). The primary outcome was change in health-related quality of life, as measured on the 4 domains of the chronic respiratory questionnaire score. There was no statistically significant difference between groups in mean change in chronic respiratory questionnaire scores. Among patients in the intervention group, the magnitude of improvement in the domains of dyspnea (0.7 points) and fatigue (0.5 points) met or exceeded the minimal clinically important difference. In the control group, the magnitude of change in all domains did not meet the minimal clinically important difference. Change in the 6MWD (a secondary outcome) did not differ significantly between groups at either follow-up. Outcomes were not reported separately for the inpatient or outpatient programs (this evidence review addresses outpatient programs). Trialists recommended that future evaluations of repeat pulmonary rehabilitation programs include patients with more serious exacerbations, last longer than 3 weeks, and start as close in time as possible to the exacerbation. Conclusions about repeat pulmonary rehabilitation programs cannot be drawn from 1 study with 33 subjects.

Maintenance Outpatient Pulmonary Rehabilitation Programs

Randomized Controlled Trials

In 2012, an Ontario Health Technology Assessment evaluated pulmonary rehabilitation for patients with COPD.[27,] Reviewers identified 3 RCTs (N=284) assessing maintenance pulmonary rehabilitation programs for individuals with COPD who had successfully completed an initial pulmonary rehabilitation program. The trials excluded patients who had experienced a recent acute exacerbation of COPD. All maintenance programs consisted of supervised exercise sessions; program duration was 3 months in 1 program and 12 months in the other 2. One program also included an unsupervised exercise component and another included educational sessions. Reviewers judged study quality as generally poor due to methodologic limitations (e.g., inadequate information on randomization, allocation concealment, blinding, and lack of clarity around the use of an intention-to-treat analysis). In a pooled analysis of data from 2 trials (n=168), there was a significantly greater improvement in 6MWD in patients who participated in the maintenance program than in those in a control group (MD=22.9 meters; 95% CI, 5.2 to 40.7). The confidence interval was wide, indicating lack of precision in the pooled estimate. Also, reviewers considered the minimal clinically important difference to be 25 to 35 meters walked, and meta-analysis of trial findings did not meet this threshold of difference between groups.

Several RCTs were published after the Ontario assessment. Güell et al (2017) published findings of a 3-year trial of patients with severe COPD.[28,] A total of 143 patients attended an initial 8-week

outpatient pulmonary rehabilitation program, and 138 were then randomized to a 3-year maintenance program (n=68) or a control group (n=70). The maintenance intervention consisted of home-based exercises, calls from a physical therapist every 2 weeks, and supervised training sessions every 2 weeks. The control group was advised to exercise at home without supervision. Some outcomes, but not others, favored the intervention group at 2 years, but outcomes did not differ significantly between groups at 3 years. For example, compared with baseline, at 2 years the 6MWD increased by 2 meters in the intervention group and decreased by 32 meters in the control group (p=.046). At 3 years, compared with baseline, the 6MWD decreased by 4 meters in the intervention group and decreased by 33 meters in the control group (p=.119). The chronic respiratory questionnaire dyspnea score, at 2 years compared with baseline, decreased by 0.4 points in the intervention group and by 0.3 points in the control group (p=.617); findings were similar at 3 years. The trial also had a high dropout rate.

Wilson et al (2015) published a single-blind RCT comparing maintenance pulmonary rehabilitation to standard care without maintenance pulmonary rehabilitation in patients who had COPD and had completed at least 60% of an initial pulmonary rehabilitation program.[29,] One hundred forty-eight patients were randomized; 110 (74%) completed the trial and were included in the analysis. The maintenance program consisted of a 2-hour session every 3 months for 1 year. The session included an hour of education and an hour of supervised individualized exercise training. The primary efficacy outcome was change from baseline (post pulmonary rehabilitation) in the chronic respiratory questionnaire dyspnea domain. Among trial completers, mean chronic respiratory questionnaire dyspnea score changed from 2.6 to 3.2 among patients receiving maintenance pulmonary rehabilitation and from 2.5 to 3.3 among controls. The difference between groups was not statistically significant. Secondary outcomes, including other chronic respiratory questionnaire domains, scores on the endurance shuttle walk test, and a number of exacerbations or hospitalizations, also did not differ significantly between groups.

Section Summary: Repeat or Maintenance Outpatient Pulmonary Rehabilitation Programs

Evidence for repeat pulmonary rehabilitation programs includes 1 small randomized study. Additional larger RCTs are needed before conclusions can be made about the effectiveness of repeat pulmonary rehabilitation. A limited number of RCTs are available to evaluate maintenance rehabilitation programs. Due to the paucity of RCTs, methodologic limitations of available trials, and lack of clinically significant findings, the evidence to determine the effect of maintenance pulmonary rehabilitation programs on health outcomes in patients with COPD is insufficient.

Home-Based Pulmonary Rehabilitation Programs

Clinical Context and Therapy Purpose

The purpose of a single course of home-based pulmonary rehabilitation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as a single course of ambulatory care–based pulmonary rehabilitation, in patients with an indication for outpatient pulmonary rehabilitation.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals with an indication for outpatient pulmonary rehabilitation.

Interventions

The therapy being considered is a single course of home-based pulmonary rehabilitation. Pulmonary rehabilitation programs include a patient assessment followed by therapeutic interventions including exercise training, education, and behavior change.

Comparators
Comparators of interest include a single course of ambulatory care–based pulmonary rehabilitation. Treatment includes physical exercise, diaphragmatic breathing, oxygen therapy, and medical therapy.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, and quality of life.
The existing literature evaluating a single course of home-based pulmonary rehabilitation indicates that 3 to 6 months duration of follow-up is desirable to assess outcomes.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence
Systematic Reviews
Evaluation of home-based pulmonary rehabilitation programs requires evidence that these programs are at least as effective as programs conducted in the ambulatory care setting. The programs also need to be comprehensive and be feasible in the United States health care system. Several RCTs and systematic reviews of RCTs have assessed home-based pulmonary rehabilitation programs. A comparison of trials included in the systematic reviews is available in Table A2 in the Appendix. Among the systematic reviews, Liu et al (2014) identified 18 RCTs evaluating home-based pulmonary rehabilitation programs.[30,] Most trials compared pulmonary rehabilitation with usual care, and none of the selected trials compared home-based with clinic-based programs. Only 2 trials were conducted in the United States, and both were published in the 1990s. All trials reported different outcomes over different timeframes, and pooled analyses only included data from 2 to 4 studies. For example, a pooled analysis of 3 studies (n=112) reporting the Saint George's Respiratory Questionnaire total score found statistically significant improvements in symptoms with home-based pulmonary rehabilitation compared with control (effect size, -11.33; 95% CI, -16.37 to -6.29). A pooled analysis of data from 4 studies (n=167) found a significantly increased 6MWD after 12 weeks in the pulmonary rehabilitation group compared with control (effect size, 35.9; 95% CI, 9.4 to 62.4). The latter analysis had a wide confidence interval, indicating an imprecise estimate of effect.

Vieira et al (2010), in a systematic review, identified 12 RCTs comparing home-based pulmonary rehabilitation with pulmonary rehabilitation in another setting or with standard care in patients who had COPD.[31,] The comparison intervention in 3 trials was a hospital-based program; in 8 trials, it was standard care; and in 1 trial, both comparisons were made. The methodologic quality of the trials was considered average to poor, and most had small sample sizes and relatively short follow-up durations. Reviewers did not pool trial findings, and findings of individual studies were mixed. Three trials that compared home-based pulmonary rehabilitation with standard care reported on between-group differences in quality of life; in all 3 studies, differences were reported as statistically significant. The 2 trials that reported differences in exercise capacity found home-based pulmonary rehabilitation to result in significantly greater improvements in the 6MWD or constant work rate test than standard care. On the other hand, in the 3 trials comparing home-based pulmonary rehabilitation and hospital-based programs, there were no statistically significant differences between groups in quality of life changes. Moreover, in the 2 trials that assessed maximal work level and the 2 trials that assessed the 6MWD, outcomes did not differ significantly from home-based or

hospital-based pulmonary rehabilitation programs. Reviewers commented that their analysis was limited by the generally low quality of the randomized trials and short-term length of follow-up. Stafinski et al (2022) identified 12 RCTs and 2 comparative observational studies (N=2293) to include in their systematic review evaluating home-based pulmonary rehabilitation programs in individuals with COPD.[32,] Nine studies compared home-based pulmonary rehabilitation to usual care, 4 compared to outpatient-pulmonary rehabilitation, and 1 compared home-based to outpatient pulmonary rehabilitation or usual care. The overall quality for most outcomes was considered low to very low, based on the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) tool. Health-related quality of life was measured across studies using the COPD assessment test, chronic respiratory disease questionnaire (CRQ), and the Saint George's respiratory questionnaire. In a meta-analysis comparing home-based to outpatient pulmonary rehabilitation in RCTs (n=2 studies) immediately after treatment, there were no differences between groups in changes in the dyspnea domain of the CRQ (MD=0.36; 95% CI, -1.34 to 2.06; p=.68), the emotional function domain of the CRQ (MD=-0.35; 95% CI, -0.83 to 0.14; p=.16), or the fatigue domain of the CRQ (MD=0.06; 95% CI, -1.16 to 1.27; p=.93). In all 4 studies comparing home-based to outpatient pulmonary rehabilitation, the 6MWD statistically significantly increased after both interventions, and the gains were similar between programs. This study demonstrated that there were no appreciable differences between home-based and outpatient pulmonary rehabilitation programs in short-term outcomes. A meta-analysis was not able to be performed on most outcomes due to a high level of heterogeneity and limited data. Additionally, long-term outcomes were not evaluated in included studies.

Another systematic review was published by Neves et al (2016).[33,] However, this review combined home- and community-based pulmonary rehabilitation programs in analyses so no conclusions can be drawn on the impact of home-based programs compared with programs based in the ambulatory care setting.

Randomized Controlled Trials

A study with a relatively large sample size that compared home-based pulmonary rehabilitation with outpatient clinic-based pulmonary rehabilitation was published by Maltais et al (2008).[34,] This noninferiority trial was conducted in Canada. Eligibility criteria included stable COPD for at least 4 weeks before study participation and no previous participation in pulmonary rehabilitation programs; 252 patients were included. All patients initially completed a 4-week self-management education program. They were then randomized to 8 weeks of self-monitored home-based exercise training or outpatient hospital-based exercise training. The exercise program included aerobic and strength exercises conducted 3 times a week. Patients were followed for 40 weeks after completion of the exercise program. Both interventions produced similar improvements in the chronic respiratory questionnaire dyspnea domain scores at 1 year: improvement in dyspnea of 0.62 (95% CI, 0.43 to 0.80) units in the home intervention (n=107) and 0.46 (95% CI, 0.28 to 0.64) units in the outpatient intervention (n=109). The difference between treatments at 1 year was considered clinically unimportant. The trial did not evaluate a comprehensive pulmonary rehabilitation program.

Section Summary: Home-Based Pulmonary Rehabilitation Programs

Most studies of home-based pulmonary rehabilitation have compared it with standard care. Very few studies have compared home-based pulmonary rehabilitation with a hospital or clinic-based pulmonary rehabilitation, and those available are mostly of low quality. Therefore, there is insufficient evidence to determine whether comprehensive pulmonary rehabilitation programs conducted in the home setting are at least as effective as comprehensive pulmonary rehabilitation programs in the ambulatory care setting.

Supplemental Information

The purpose of the following information is to provide reference material. Inclusion does not imply endorsement or alignment with the evidence review conclusions.

Practice Guidelines and Position Statements

Guidelines or position statements will be considered for inclusion in 'Supplemental Information' if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

American College of Physicians

In 2011, joint guidelines on the management of stable chronic obstructive pulmonary disease (COPD) were issued by the American College of Physicians, the American College of Chest Physicians, the American Thoracic Society (ATS), and the European Respiratory Society.[35,] The guidelines recommended that "clinicians should prescribe pulmonary rehabilitation for symptomatic patients with an FEV_1 [forced expiratory volume in 1 second] <50% predicted (Grade: strong recommendation, moderate-quality evidence). Clinicians may consider pulmonary rehabilitation for symptomatic or exercise-limited patients with an FEV_1 >50% predicted (Grade: weak recommendation, moderate-quality evidence)."

American Thoracic Society and European Respiratory Society

A 2015 joint statement on pulmonary rehabilitation was issued by the ATS and the European Respiratory Society.[36,] The statement included the following relevant conclusions:

- "Pulmonary rehabilitation (PR) has demonstrated physiological, symptom-reducing, psychosocial, and health economic benefits in multiple outcome areas for patients with chronic respiratory diseases."
- "The evidence indicates that patients who benefit from PR include not only persons with moderate to severe airflow limitation but also those with mild to moderate airflow limitation with symptom-limited exercise tolerance, those after hospitalization for COPD exacerbation, and those with symptomatic non-COPD respiratory conditions."
- "Patients graduating from a PR program stand to benefit from a home, community-based, or program-based maintenance exercise program to support the continuation of positive exercise behavior."

In 2017, the Society issued a joint statement on the management of COPD exacerbation.[37,] For patients hospitalized with a COPD exacerbation, they suggest "the initiation of pulmonary rehabilitation within 3 weeks after hospital discharge" (strength: conditional; quality of evidence: very low). In addition, "[they] suggest not initiating pulmonary rehabilitation during hospitalisation" (strength: conditional; quality of evidence: very low).

In 2021, the ATS published a report from a workshop that was convened to achieve consensus on the essential components of pulmonary rehabilitation and to identify requirements for successful implementation of emerging program models.[38,] A Delphi process involving experts from across the world identified 13 "essential" components of pulmonary rehabilitation that must be delivered in any program model, encompassing patient assessment, program content, method of delivery, and quality assurance; an additional 27 "desirable" components were also identified. See the full text of this publication for further details.

Global Initiative for Chronic Obstructive Lung Disease

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) updates their guidelines annually on the diagnosis, management, and prevention of COPD.[39,] In their 2023 guidance, GOLD notes that: "Pulmonary rehabilitation should be considered as part of integrated patient management... Optimum benefits are achieved from programs lasting 6 to 8 weeks. Available evidence indicates that there are no additional benefits from extending pulmonary rehabilitation to 12 weeks.

Supervised exercise training at least twice weekly is recommended, and this can include any regimen from endurance training, interval training, resistance/strength training; upper and lower limbs ideally

should be included as well as walking exercise; flexibility, inspiratory muscle training and neuromuscular electrical stimulation can also be incorporated. In all cases the rehabilitation intervention (content, scope, frequency, and intensity) should be individualized to maximize personal functional gains."

The benefits to patients with COPD from pulmonary rehabilitation cited in the guidelines are listed in Table 13.

Table 13. Benefits of Pulmonary Rehabilitation in Patients with COPD (GOLD guidelines)

Pulmonary Rehabilitation Benefit	LOE
Pulmonary rehabilitation improves dyspnea, health status, and exercise tolerance in stable patients.	A
Pulmonary rehabilitation reduces hospitalization among patients who have had a recent exacerbation (≤4 weeks from prior hospitalization).	B
Pulmonary rehabilitation leads to a reduction in symptoms of anxiety and depression.	A

COPD: chronic obstructive pulmonary disease; GOLD: Global Initiative for Chronic Obstructive Lung Disease; LOE: level of evidence.

Related to the setting of pulmonary rehabilitation, the GOLD guidelines state that "community-based and home-based programs have been shown to be as effective as hospital-based programs in randomized controlled trials, as long as the frequency and intensity are equivalent." This statement cites studies described alone or included in systematic reviews in the Rationale Section (Maltais et al 2008 and Holland et al 2017).

U.S. Preventive Services Task Force Recommendations

Not applicable.

Medicare National Coverage

In 2007, the Centers for Medicare & Medicaid Services affirmed its position that a national coverage determination for pulmonary rehabilitation is not appropriate.[40,]

Ongoing and Unpublished Clinical Trials

Some currently ongoing and unpublished trials that might influence this review are listed in Table 14.

Table 14. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Ongoing			
NCT05136300	Pulmonary Rehabilitation After Minimal Invasive Surgery in Lung Cancer	100	Jul 2023
NCT03326089	Short and Long-term Effects of Oxygen Supplemented Pulmonary Rehabilitation in Idiopathic Pulmonary Fibrosis	20	Sep 2022
NCT02842463	Use of the 6-minute Stepper Test to Individualise Pulmonary Rehabilitation in Patients With Mild to Moderate Chronic Obstructive Pulmonary Disease	80	Dec 2023
Unpublished			
NCT03299504	Factors Predicting Success in Lung Transplant Recipients Who Have Participated in the COLTT Program (Daily Intensive Post-hospitalization Rehabilitation): A Retrospective Review	105	Apr 2018 (last updated 08/24/18)
NCT03244137	Effects of Pulmonary Rehabilitation on Cognitive Function in Patients With Severe to Very Severe Chronic Obstructive Pulmonary Disease	56	Dec 2019 (last updated 01/07/20)
NCT02426437	How Does Early Rehabilitation Affect Patient-centred Health Outcomes and Cardiovascular Risk in COPD Patients	87	Dec 2019 (last updated 04/08/21)

NCT: national clinical trial.

Appendix 1

Table A1. Comparison of Trials/Studies Included in SR & M-A for Idiopathic Pulmonary Fibrosis.

Study	Cheng (2018)[11,]	Yu (2019)[10,]	Downman (2021)[9,]
Baradzina (2005)			●
Dale (2014)			●
Dariusz (2008)		●	
De Las Hera (2019)			●
Downman (2017)	●		●
Gaunaurd (2014)			●
He (2016)		●	●
Holland (2008)			●
Jackson (2014)	●	●	●
Jarosch (2020)			●
Ku (2017)			●
Lanza (2019)			●
Mejia (2000)			●
Menon (2011)			●
Naz (2018)			●
Nishiyama (2008)	●	●	●
Perez Bogerd (2018)			●
Shen (2016)			●
Vainshelboim (2014)			●
Vainshelboim (2015)	●	●	
Vainshelboim (2016)		●	
Vainshelboim (2017)	●		
Wallaert (2020)			●
Wewel (2005)			●
Xiao (2019)			●

M-A: meta-analysis; SR: systematic review.

Table A2. Comparison of Trials/Studies Included in SR & M-A for Home-Based Pulmonary Rehabilitation.

Study	Vieira (2010)[31,]	Liu (2014)[30,]	Stafinski (2022)[32,]
McGavin et al (1977)	●		
Busch and McClements (1988)	●	●	
Wijkstra et al (1994)		●	
Wijkstra et al (1996)		●	
Bauldoff et al (1996)		●	
Strijbos et al (1996)	●		
Wedzicha et al (1998)		●	
Larson et al (1999)		●	
Hernandez et al (2000)	●	●	
Puente-Maestu et al (2000)	●		
Oh (2003)		●	
Singh et al (2003)	●	●	
Xie et al (2003)		●	
Man et al (2004)		●	
Boxall et al (2005)	●	●	
Murphy et al (2005)	●		
Koppers et al (2006)		●	
O'Shea et al (2007)		●	
Resqueti et al (2007)	●		
Güell et al (2008)	●		
Maltais et al (2008)	●		

Study	Vieira (2010)[31,]	Liu (2014)[30,]	Stafinski (2022)[32,]
du Moulin et al (2009)		●	
Fernandez et al (2009)	●	●	
Moore et al (2009)			●
Ghanem et al (2010)		●	
de Oliveira et al (2010)			●
Akinci and Olgun (2011)		●	
Liu et al (2013)			●
De Sousa et al (2014)			●
Khoshkesht et al (2015)			●
Pradella et al (2015)			●
Chaplin et al (2017)			●
Holland et al (2017)			●
Lalmolda et al (2017)			●
Coultas et al (2018)			●
Horton et al (2018)			●
Li et al (2018)			●
Nolan et al (2019)			●
Lahham et al (2020)			●

M-A: meta-analysis; SR: systematic review.

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Documentation for Clinical Review

Please provide the following documentation:

- History and physical and/or pulmonologist consultation notes including:
- Current disease condition(s) and comorbidity status
- Current functional, mobility, and psychosocial status including impression of patient's ability to be an adequate candidate for outpatient pulmonary rehabilitation
- Documentation of pulmonary event(s) including dates of occurrence
- Individualized treatment plan (description of the diagnosis (including disease staging), type/amount/frequency and duration of medical management plan)
- Synopsis of alternative treatments performed and results
- Surgical procedure(s) and procedure date(s) pertaining to request
- Type of pulmonary rehabilitation program and components requested

Post Service (in addition to the above, please include the following):

- Provider measured outcomes assessment (e.g., following lung transplantation)
- Operative report(s)

Coding

This Policy relates only to the services or supplies described herein. Benefits may vary according to product design; therefore, contract language should be reviewed before applying the terms of the Policy.

The following codes are included below for informational purposes. Inclusion or exclusion of a code(s) does not constitute or imply member coverage or provider reimbursement policy. Policy Statements are intended to provide member coverage information and may include the use of some codes for clarity. The Policy Guidelines section may also provide additional information for how to interpret the Policy Statements and to provide coding guidance in some cases.

Type	Code	Description
CPT®	94625	Physician or other qualified health care professional services for outpatient pulmonary rehabilitation; without continuous oximetry monitoring (per session)
	94626	Physician or other qualified health care professional services for outpatient pulmonary rehabilitation; with continuous oximetry monitoring (per session)
HCPCS	G0237	Therapeutic procedures to increase strength or endurance of respiratory muscles, face-to-face, one-on-one, each 15 minutes (includes monitoring)
	G0238	Therapeutic procedures to improve respiratory function, other than described by G0237, one-on-one, face-to-face, per 15 minutes (includes monitoring)
	G0239	Therapeutic procedures to improve respiratory function or increase strength or endurance of respiratory muscles, 2 or more individuals (includes monitoring)
	G0302	Preoperative pulmonary surgery services for preparation for LVRS, complete course of services, to include a minimum of 16 days of services
	G0303	Preoperative pulmonary surgery services for preparation for LVRS, 10 to 15 days of services
	G0304	Preoperative pulmonary surgery services for preparation for LVRS, 1 to 9 days of services
	G0305	Post discharge pulmonary surgery services after LVRS, minimum of 6 days of services
	G0424	Pulmonary rehabilitation, including exercise (includes monitoring), one hour, per session, up to 2 sessions per day
	S9473	Pulmonary rehabilitation program, nonphysician provider, per diem

Policy History

This section provides a chronological history of the activities, updates and changes that have occurred with this Medical Policy.

Effective Date	Action	Reason
04/30/2015	BCBSA Medical Policy adoption	Medical Policy Committee
06/01/2016	Policy revision without position change	Medical Policy Committee
05/01/2017	Policy revision without position change	Medical Policy Committee
05/01/2018	Policy revision without position change	Medical Policy Committee
06/01/2019	Policy revision without position change	Medical Policy Committee

Effective Date	Action	Reason
06/01/2023	Policy reactivated. Previously archived from 06/01/2020 to 05/31/2023.	Medical Policy Committee

Definitions of Decision Determinations

Medically Necessary: Services that are Medically Necessary include only those which have been established as safe and effective, are furnished under generally accepted professional standards to treat illness, injury or medical condition, and which, as determined by Blue Shield, are: (a) consistent with Blue Shield medical policy; (b) consistent with the symptoms or diagnosis; (c) not furnished primarily for the convenience of the patient, the attending Physician or other provider; (d) furnished at the most appropriate level which can be provided safely and effectively to the patient; and (e) not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of the Member's illness, injury, or disease.

Investigational/Experimental: A treatment, procedure, or drug is investigational when it has not been recognized as safe and effective for use in treating the particular condition in accordance with generally accepted professional medical standards. This includes services where approval by the federal or state governmental is required prior to use, but has not yet been granted.

Split Evaluation: Blue Shield of California/Blue Shield of California Life & Health Insurance Company (Blue Shield) policy review can result in a split evaluation, where a treatment, procedure, or drug will be considered to be investigational for certain indications or conditions, but will be deemed safe and effective for other indications or conditions, and therefore potentially medically necessary in those instances.

Prior Authorization Requirements and Feedback (as applicable to your plan)

Within five days before the actual date of service, the provider must confirm with Blue Shield that the member's health plan coverage is still in effect. Blue Shield reserves the right to revoke an authorization prior to services being rendered based on cancellation of the member's eligibility. Final determination of benefits will be made after review of the claim for limitations or exclusions.

Questions regarding the applicability of this policy should be directed to the Prior Authorization Department at (800) 541-6652, or the Transplant Case Management Department at (800) 637-2066 ext. 3507708 or visit the provider portal at www.blueshieldca.com/provider.

We are interested in receiving feedback relative to developing, adopting, and reviewing criteria for medical policy. Any licensed practitioner who is contracted with Blue Shield of California or Blue Shield of California Promise Health Plan is welcome to provide comments, suggestions, or concerns. Our internal policy committees will receive and take your comments into consideration.

For utilization and medical policy feedback, please send comments to: MedPolicy@blueshieldca.com

Disclaimer: This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. Blue Shield of California may consider published peer-reviewed scientific literature, national guidelines, and local standards of practice in developing its medical policy. Federal and state law, as well as contract language, including definitions and specific contract provisions/exclusions, take precedence over medical policy and must be considered first in determining covered services. Member contracts may differ in their benefits. Blue Shield reserves the right to review and update policies as appropriate.

Appendix A

POLICY STATEMENT	
BEFORE	**AFTER** **Blue font: Verbiage Changes/Additions**
Reactivated Policy **Policy Statement:** N/A	**Outpatient Pulmonary Rehabilitation 8.03.05** **Policy Statement:** I. A single course of pulmonary rehabilitation in the outpatient ambulatory care setting may be considered **medically necessary** for treatment of **either** of the following: A. Chronic pulmonary disease for individuals with moderate-to-severe disease who are experiencing disabling symptoms and significantly diminished quality of life despite optimal medical management B. As a preoperative conditioning component for those considered appropriate candidates for lung volume reduction surgery (see Blue Shield of California Medical Policy: Lung Volume Reduction Surgery for Severe Emphysema) or for lung transplantation (see Blue Shield of California Medical Policy: Lung and Lobar Lung Transplant II. Pulmonary rehabilitation programs may be considered **medically necessary** following lung transplantation. III. Multiple courses of pulmonary rehabilitation are considered **investigational** for **either** of the following: A. As maintenance therapy in individuals who initially respond B. In individuals who fail to respond, or whose response to an initial rehabilitation program has diminished over time IV. Pulmonary rehabilitation programs are considered **investigational** for **any** of the following: A. Home-based pulmonary rehabilitation programs B. Following other types of lung surgery, included but not limited to lung volume reduction surgery and surgical resection of lung cancer

POLICY STATEMENT	
BEFORE	**AFTER** **Blue font: Verbiage Changes/Additions**
	C. Pulmonary rehabilitation programs in all other situations outside of the medical necessity criteria