

## Pulmonary Rehabilitation

---

**Policy Number:**

MM.09.008

**Line(s) of Business:**

PPO; HMO; QUEST Integration

**Section:**

Rehabilitative Therapy

**Place(s) of Service:**

Outpatient

**Original Effective Date:**

06/01/2017

**Current Effective Date:**

7/27/2018

### I. 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.

The American Thoracic Society (ATS) and the European Respiratory Society (ERS) define 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.” PR programs are intended to improve the patient’s functioning and quality of life. Most research has focused on patients with chronic obstructive pulmonary disease (COPD), although there has been some interest in PR 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.

### II. Criteria/Guidelines

A single course of pulmonary rehabilitation in the outpatient ambulatory care setting is covered (subject to Limitations and Administrative Guideline) when the following criteria are met:

A. The patient has one of the following conditions:

1. The patient has moderate to severe chronic pulmonary disease which results in disabling symptoms and significantly diminished quality of life despite optimal medical management.
2. The patient is considered to be an appropriate candidate for lung volume reduction surgery or for lung transplantation and requires preoperative conditioning.
3. The patient has undergone lung transplantation.

- B. The patient is medically stable and not limited by another serious or unstable medical condition.
- C. The pulmonary rehabilitation outpatient program is a comprehensive, multidisciplinary, goal directed program that generally includes the following:
  - 1. Team assessment and formulation of an individual treatment plan.
  - 2. Patient education and training that addresses breathing retraining, bronchial hygiene, medications and proper nutrition.
  - 3. Psychosocial assessment and/or intervention that addresses support system and dependency issues.
  - 4. Exercise training that 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.
  - 5. Formulation and monitoring of an ongoing home exercise program.
  - 6. Outcomes assessment including initial and periodic evaluations based on patient-centered outcomes and objective clinical measures of effectiveness of the program.
- D. The pulmonary rehabilitation program is currently accredited:
  - 1. For outpatient free standing facilities, the program has been approved by the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR).
  - 2. For hospital-based facilities, the program has been accredited by AACVPR or by the Joint Commission on Accreditation of Healthcare Organizations (JACHO).
  - 3. At HMSA's discretion, exceptions can be made for programs that are actively pursuing accreditation.

### III. Limitations

- A. Multiple courses (with the exception of one course before lung transplant and one course following lung transplant) of pulmonary rehabilitation are not covered, either as maintenance therapy in patients who initially respond or in patients who fail to respond or whose response to an initial rehabilitation program has diminished over time.
- B. Home-based pulmonary rehabilitation programs are not covered.
- C. Pulmonary rehabilitation programs are not covered following other types of lung surgery, included but not limited to lung volume reduction surgery and surgical resection of lung cancer.
- D. Pulmonary rehabilitation is limited to 18 sessions. Up to an additional 18 sessions may be covered when medically necessary. Services should be discontinued at any time under the following circumstances:
  - 1. There is no clear, measurable progress toward the stated rehabilitation goal.
  - 2. Ability to perform activities of daily living has been restored.
  - 3. There is no therapeutic benefit or likelihood of improvement beyond what is expected with performance of activities of daily living and prescribed home exercise program and passage of time.

- E. Pulmonary rehabilitation is not covered for medically unstable patients and/or patients who are limited by another serious or unstable medical condition. Contraindications to pulmonary rehabilitation include, but are not limited to:
1. Severe neuropsychiatric disturbance (e.g., dementia, organic brain syndrome; inability to follow directions; inability to remember to perform activities); or
  2. Significant or unstable medical conditions (e.g., heart failure, acute cor pulmonale, substance abuse, significant liver dysfunction, metastatic cancer, disabling stroke, coronary artery disease).

#### IV. Administrative Guidelines

- A. Precertification is required for the initial 18 sessions. Documentation supporting that criteria II.A to D are met must be submitted. To precertify, please complete HMSA's [Precertification Request](#) and mail or fax the form, or use iExchange as indicated.
- B. Precertification is required for continuation beyond 18 sessions. Initial evaluation and outcomes assessments including current re-evaluation must be submitted.
- C. Precertification is not required for Medicare Advantage.

CPT Codes	Description
94664	Demonstration and/or evaluation of patient utilization of an aerosol generator, nebulizer, metered dose inhaler or IPPB device
94667	Manipulation chest wall, such as cupping, percussing, and vibration to facilitate lung function; initial demonstration and/or evaluation
HCPCS Codes	Description
G0424	Pulmonary rehabilitation, including exercise (includes monitoring), one hour, per session, up to two sessions per day
G0239	Therapeutic procedures to improve respiratory function or increase strength or endurance of respiratory muscles, two or more individuals (includes monitoring)
ICD-10-CM	Description
*Z71.6	Tobacco abuse counseling
*Z71.3	Dietary counseling and surveillance

*\*ICD-10-CM Diagnosis codes are used for secondary diagnosis*

#### V. Scientific Background

The policy was based on a TEC Assessment and updated with searches of the MEDLINE database. Most recently, the literature was reviewed through January 11, 2018.

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 one 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.

The focus of this policy will be on comprehensive, multidisciplinary programs that include an exercise component plus other modalities. Where there is a lack of evidence on multidisciplinary pulmonary rehabilitation (PR) programs, interventions that are strictly exercise will be considered. In this regard, it is considered that 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 will improve outcomes to the same degree or greater. Following is a summary of the literature to date.

### **Chronic Obstructive Pulmonary Disease**

Numerous randomized controlled trials (RCTs) and several systematic reviews of RCTs have been published. Most recently, Puhan et al (2016) published a Cochrane review that evaluated PR programs for patients who had an exacerbation of chronic obstructive pulmonary disease (COPD). To be included, the rehabilitation program needed to begin within three weeks of initiating exacerbation treatment and had to include physical exercise. Twenty trials (total N=1477 participants) 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 PR compared with usual care (odds ratio [OR], 0.44; 95% confidence interval [CI], 0.21 to 0.91). Several secondary outcomes also favored the PR 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 PR groups (mean difference [MD], 62.4 meters; 95% CI, 38.5 to 86.3 meters). Moreover, a pooled analysis of health-related quality of life (HRQOL) found significantly greater improvement after PR 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.

McCarthy et al (2015) published a Cochrane review that included RCTs assessing the effect of outpatient or inpatient PR on functional outcomes and/or disease-specific quality of life (QOL) in patients with COPD. PR 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 (total N=3822 participants) met inclusion criteria. COPD severity 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 statistically significantly greater improvement in all outcomes in PR groups than in usual care groups. In addition, between-group differences on key outcomes were clinically significant. For example, on all 4 important domains of the validated Chronic Respiratory Questionnaire (CRQ)-dyspnea, fatigue, emotional function, and mastery-the effect was larger than the accepted minimal clinically important difference (MCID) of 0.5 units.

In addition, the between-group difference in maximal exercise capacity exceeded the MCID 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 (total N=489 participants). Inspection of the trial designs for the 4 RCTs indicated that none actually evaluated a comprehensive PR program in patients who met criteria for mild COPD. Rather than being comprehensive PR 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. In addition, none of the RCTs enrolled a patient population with only mild COPD. Roman et al (2013) and Gottlieb et al (2011) included patients with moderate COPD, Liu et al (2012) included patients with mild-to-moderate COPD, and van Wetering et al (2010) included patients with moderate-to-severe COPD. Conclusions cannot be drawn about the efficacy of PR in patients with mild COPD from this systematic review.

### **Section Summary: Chronic Obstructive Pulmonary Disease**

Multiple RCTs and meta-analyses of RCTs have been published and, for the most part, these have found improved outcomes (i.e., functional ability, QOL) in patients with moderate to severe COPD who undergo a comprehensive PR program in the outpatient setting. There is limited evidence on the efficacy of repeated and/or prolonged PR programs, and the available evidence is mixed on whether these programs lead to additional health outcome benefits.

### **Idiopathic Pulmonary Fibrosis**

Jackson et al (2014) evaluated patients with idiopathic pulmonary fibrosis (IPF) who were 40 to 80 years of age and had disease onset between 3 and 48 months before screening, abnormal pulmonary function, and a 6MWD between 150 and 500 meters. In this pilot RCT, patients were assigned to a PR program consisting of twice-weekly 2-hour rehabilitation sessions over 12 weeks (n=14) or usual care (n=11). Twenty-one of the 25 patients completed the 3-month intervention study. Reviewers did not report between-group statistics. Follow-up data at 3 months post intervention were reported by Gaunard et al (2014). During the intervention, patients in the PR group had significantly greater self-

reported physical activity, but, in the subsequent 3 months, activity levels in the 2 groups were similar. For example, at 6 months, pulmonary function measures (e.g., total lung capacity, forced vital capacity [FVC], spirometry diffusion capacity) did not change significantly within either group. 6MWD was not reported.

### **Section Summary: Idiopathic Pulmonary Fibrosis**

One small RCT has evaluated a comprehensive PR program in patients with IPF; at 3 months post intervention, outcomes did not differ between groups that did and did not receive PR.

### **Bronchiectasis**

Lee et al (2017) published a systematic review of RCTs on PR in patients with non-cystic fibrosis bronchiectasis. 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 (ISWD) 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 St. George's Respiratory Questionnaire (SGRQ) score post intervention (MD = -4.65; 95% CI, -6.70 to -2.60). There was no significant difference post intervention on the Leicester Cough Questionnaire (total) scores. Reviewers did not conduct meta-analyses of data beyond the immediate post intervention period.

### **Section Summary: Bronchiectasis**

A systematic review of RCTs on PR for patients with bronchiectasis found that some, but not all, outcomes improved more with PR than with a nonexercise control condition immediately post intervention. Limited observational data suggest that outcomes in patients with other respiratory conditions may benefit, but likely not as much as COPD patients.

### **PR Programs before Lung Surgery**

#### **Lung Volume Reduction Surgery**

PR prior to lung volume reduction surgery (LVRS) represents a distinct subset of patients with COPD, and the National Emphysema Treatment Trial (NETT) requires all candidates to undergo a vigorous course of PR. The final NETT results supported the treatment effectiveness in a subset of patients with COPD.

#### **Lung Transplantation**

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

### **Lung Cancer Resection**

Several small RCTs have evaluated preoperative PR for patients undergoing lung cancer resection. Morano et al (2013) conducted a single-blind study in Brazil. Patients with non-small-cell lung cancer (NSCLC) eligible for lung resection were randomized to 4 weeks of an exercise-only PR program (5 sessions per week) or to chest physical therapy; there were 12 patients in each group. All patients in the PR 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 PR group spent significantly fewer days in the hospital (mean, 7.8 days) than patients in the chest physical therapy group (mean, 12.2 days;  $p=0.04$ ). In addition, patients in the PR group spent fewer days with chest tubes (mean, 4.5 days) than the physical therapy group (mean, 7.4 days;  $p=0.03$ ). The trial did not assess longer term functional outcomes after surgery.

Benzo et al (2011) conducted 2 small exploratory RCTs evaluating PR before lung cancer resection. 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 PR program ( $n=10$ ) or usual care ( $n=9$ ). Mean number of days in the hospital was 6.3 in the PR group and 11.0 in the control group ( $p=0.058$ ). Three (33%) patients in the PR group and 5 (63%) patients in the control group experienced postoperative pulmonary complications ( $p=0.23$ ). 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.

Bradley et al (2013), in a nonrandomized comparative study evaluated an outpatient-based PR intervention in 58 lung cancer patients who were candidates for surgery. This U.K.-based study by Bradley et al 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 PR program. In between-group analyses, there were not statistically significant differences between the intervention and comparison groups in clinical outcomes such as postoperative pulmonary complications, readmissions, and mortality after surgery.

### **Section Summary: PR Programs before Lung Surgery**

There is a lack of large RCTs comparing PR with no PR for preoperative candidates undergoing LVRS, lung transplantation, or lung cancer resection. Moreover, the available studies evaluated exercise programs, but not necessarily comprehensive PR. In addition, the few small RCTs and observational studies have reported short-term outcomes and have found inconsistent evidence of benefit even on these outcomes. However, NETT did require PR before LVRS, which is the standard of care before LVRS and lung transplantation.

### **PR Programs after Lung Surgery Lung Volume Reduction Surgery**

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

#### **Section Summary: PR Programs after LVRS**

No comparative studies have evaluated PR programs after LVRS. One case series has evaluated a comprehensive PR program after LVRS in 49 patients who had not received preoperative PR. HRQOL was higher at 3 to 6 months and 12 to 18 months postsurgery. The study did not provide data on patients who underwent LVRS and did not have postoperative PR or on patients who had preoperative PR.

### **Lung Transplantation**

There is literature on exercise training after lung transplantation (not necessarily provided in comprehensive PR programs). Wickerson et al (2010) published a systematic review of RCTs and nonrandomized studies that evaluated any type of exercise intervention in lung transplantation. Seven studies met inclusion criteria; 2 were RCTs, 2 were noncontrolled, and 1 used healthy controls. The authors did not pool study findings. The 2 RCTs both evaluated lumbar extension training and its impact on lumbar bone mineral density; neither reported functional outcomes. The uncontrolled studies reported that there were improvements in functional status following exercise interventions.

Langer et al (2012) conducted an RCT in the U.K. that examined activity-related outcomes in lung transplant recipients after exercise training. The trial included 40 patients between the ages of 40 and 65 years who underwent single or double lung transplantation and had an uncomplicated postoperative period. Following hospital discharge, patients were randomized to undergo a supervised exercise program 3 times a week for 3 months (n=21) or usual care with instructions to exercise (n=19). Patients in both groups had 6 individual counselling sessions in the 6 months post discharge. Six patients dropped out of the study, 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 time was significantly longer in the intervention than control group. At 1 year, the exercise group walked a mean of 85 minutes per day and the control group walked a mean of 54 minutes per day ( $p=0.006$ ). Other outcomes related to daily physical activity were reported as secondary outcomes and some, but not all, significantly favored the intervention group. The mean 6MWD at 1 year was 86% of predicted in the exercise group and 74% of predicted in the control group ( $p=0.002$ ). 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) vs long (14-week) rehabilitation programs for patients who underwent lung transplantation. The primary outcome was change in the 6-minute walking test (6MWT). Secondary outcomes included the strength of the quadriceps and hamstring muscles (as measured by an isokinetic dynamometer), and QOL (as measured by the 36-Item Short-Form Health Survey). In both the 7- and 14-week rehabilitation groups, participants increased their 6MWT (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.

Munro et al (2009) published a case series that evaluated a comprehensive PR program after lung surgery. The 7-week program, which started 1 month postsurgery, 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 ( $p<0.001$ ). For example, mean forced expiratory volume in 1 second was 71% 1 month, postsurgery 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 PR program is unknown.

### **Section Summary: PR Programs after Lung Transplantation**

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

**Lung Cancer Resection**

Stigt et al (2013) published an RCT evaluating a multicomponent postsurgery PR program in patients with resectable lung cancer. The trial was conducted in the Netherlands. Before thoracotomy, 57 patients were randomized to PR (n=23) or usual care (n=26). The 12-week PR 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 thorascopic surgery, and few patients were choosing thoracotomy. Data on 49 patients were analyzed. The primary end point was QOL, as measured by the difference between groups in change in the total SGRQ score from baseline to 12 months. This difference (SD) was 2.71 (6.90) points and was not statistically significant ( $p=0.69$ ). However, the 6MWD, a secondary outcome, improved significantly more in the PR group than the usual care group at 3 months. The between-group difference (SD) in 6MWD was 94 (38) meters ( $p=0.024$ ). A limitation of this analysis is that only 8 of 23 patients in the PR performed a 6MWD at 3 months; the other 15 patients had dropped out or felt unable to take the test. Eleven of 25 patients in the usual care group performed the 6MWD test.

An exercise-only intervention after lung cancer surgery (not comprehensive PR) was evaluated in an RCT published by Edvardsen et al (2015). This single-blind study was conducted in Norway and included lung cancer patients 4 to 6 weeks postsurgery. A total of 61 patients were randomized to undergo an exercise program 3 times a week for 20 weeks or usual care. The exercise intervention took place at local fitness centers and was supervised by trained personal trainers and physical therapists. The primary outcome, change in peak oxygen uptake from baseline to the end of the intervention, was significantly greater in the intervention group than the control group (between-group difference: 0.26 L/min;  $p=0.005$ .) Findings on secondary outcomes were mixed. For example, the between-group difference in FEV1 was 0.6% predicted (95% CI: -4.2 to 5.4;  $p=0.738$ ) and the difference in stair run was 4.3 steps (95% CI: 1.6 to 7.1;  $p=0.002$ ). This study did not report other functional outcomes such as 6MWD.

**Subsection Summary: Lung Cancer Resection**

A small RCT has evaluated a comprehensive PR 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 PR programs to those who have had lung resection.

**Repeat and Maintenance PR Programs**

Both repeat and maintenance PR programs provide additional rehabilitation services after initial participation in a PR program. Program categories are not strictly defined but repeat programs are generally considered to be those that include patients who failed to respond to an initial program or whose response to an initial rehabilitation program has diminished over time. In contrast, maintenance programs tend to be those designed to maintain the effects of the initial PR program, and they are open to all patients who successfully completed an initial program.

**Repeat PR Program**

One RCT was identified that evaluated a repeat PR program. 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 PR program. Initially, patients completed either a 6-week inpatient program or a 12-week outpatient program. The repeat PR program lasted 3 weeks and consisted of exercise and education; patients could choose inpatient or outpatient versions. Over 6 months, 41 patients developed an exacerbation and 12 did not. Seven patients withdrew from the study, and the remaining 34 were randomly assigned to receive a repeat PR program within 1 month of the exacerbation (n=17) or no repeat PR 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 of 16 patients (56%) remaining in the intervention group chose an inpatient program and 7 chose an outpatient program. Patients were assessed before the repeat PR program, immediately after the program (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 HRQOL, as measured by the CRQ, a validated measure with 4 domains. There was no statistically significant difference between groups in change in CRQ 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 minimum clinically important difference (MCID). In the control group, the magnitude of change in all dimensions did not meet the MCID. Change in the 6MWD, a secondary outcome, was not significantly different between groups at either follow-up time. Outcomes were not reported separately for patients who chose inpatient versus outpatient programs (the policy addresses outpatient programs). Trialists recommended that future evaluations of repeat PR 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 PR programs cannot be drawn from 1 study with 33 subjects.

**Maintenance PR Program**

In 2012, an Ontario Health Technology Assessment evaluated PR for patients with COPD. Reviewers identified 3 RCTs (total N=284 participants) assessing maintenance PR programs for individuals with COPD who had successfully completed an initial PR 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 programs. One program also included an unsupervised exercise component, and 1 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 patients), 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 meters). The confidence interval was wide, indicating lack of precision in the pooled estimate. In addition, reviewers considered the MCID 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. Guell et al (2017) published findings of a 3-year trial of patients with severe COPD. A total of 143 patients attended an initial 8-week outpatient PR program and 138 were then randomized to a 3-year maintenance program (n=68) or to 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=0.046). 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=0.119). The CRQ 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=0.617); 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 PR to standard care without maintenance PR in patients with COPD who had completed at least 60% of an initial PR program.<sup>27</sup> 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-PR) in the CRQ dyspnea domain. Among trial completers, mean CRQ dyspnea score changed from 2.6 to 3.2 among patients receiving maintenance PR and from 2.5 to 3.3 among controls. The difference between groups was not statistically significant. Secondary outcomes, including other CRQ domains, scores on the endurance shuttle walk test (ESWT), and number of exacerbations or hospitalizations, also did not differ significantly between groups.

### **Section Summary: Repeat and Maintenance PR Programs**

A few small RCTs have been performed that evaluate repeat or 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 repeat and maintenance PR programs on health outcomes in patients with COPD is insufficient.

### **Home-Based PR Programs**

Evaluation of home-based PR programs involves searching for 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 U.S. health care system. Several RCTs and systematic reviews of RCTs have assessed home-based PR programs. Among the systematic reviews, Liu et al (2014) identified 18 RCTs evaluating home-based PR programs. Most trials compared PR 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 patients) reporting the SGRQ total score found statistically significant improvements in symptoms with home-based PR compared with control (effect size, -11.33; 95% CI, -16.37 to -6.29). A pooled analysis of data from 4 studies (n=167 patients) found a significantly increased 6MWD after 12 weeks in the PR group compared with control (effect size, 35.9; 95% CI, 9.4 to 62.4). The latter analysis had a wide confidence interval, indicating that estimate of effect was imprecise.

Vieira et al (2010), in a systematic review, identified 12 RCTs comparing home-based PR to PR in another setting or to standard care in patients with COPD. 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 PR with standard care reported on between-group differences in QOL; in all 3 studies, differences were reported as statistically significant. The 2 trials that reported differences in exercise capacity found home-based PR 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 PR and hospital-based programs, there were no statistically significant differences between groups in QOL changes. Moreover, in the 2 trials that assessed maximal work level and the 2 trials that assessed the 6MWD, outcomes did not differ significantly after home-based or hospital-based PR programs. Reviewers commented that their analysis was limited by the generally low quality of the randomized trials and short-term length of follow-up.

Another systematic review was published by Neves et al (2016). However, this review combined home and community-based PR 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.

A study with a relatively large sample size and that compared home-based PR with outpatient clinic-based PR was published by Maltais et al (2008). 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 PR programs; 252 patients were included. All patients initially completed a 4-week self-management educational program. They were then randomized to receive 8 weeks of self-monitored home-based exercise training or to 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 CRQ 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 PR program.

**Section Summary: Home-Based PR Program**

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

**Summary of Evidence****Chronic Pulmonary Disease Rehabilitation**

For individuals with moderate-to-severe chronic obstructive pulmonary disease (COPD) who receive a single course of outpatient pulmonary rehabilitation (PR), the evidence includes numerous randomized controlled trials (RCTs) and systematic reviews. Relevant outcomes are symptoms, functional outcomes, and quality of life. The published studies found improved outcomes (i.e., functional ability, quality of life) in patients with moderate-to-severe COPD who underwent a comprehensive PR program in the outpatient setting. Among the many randomized trials, the structure of the PR programs varies, so it is not possible to provide guidance on the optimal components or duration of a PR program. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals with idiopathic pulmonary fibrosis (IPF) who receive a single course of outpatient PR, the evidence includes an RCT. Relevant outcomes are symptoms, functional outcomes, and quality of life. The number of controlled studies is limited. One small RCT evaluated a comprehensive PR program in patients with IPF; at 3 months post intervention, outcomes did not differ between groups who did and did not receive PR. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals with bronchiectasis who receive a single course of outpatient PR, the evidence includes RCTs, systematic reviews, and observational data. Relevant outcomes are symptoms, functional outcomes, and quality of life. A systematic review of 4 RCTs on PR for patients with bronchiectasis found that some, but not all, outcomes, improved more with PR than with nonexercise control conditions immediately after the intervention. The evidence is insufficient to determine the effects of the technology on health outcomes.

**Preparation for Lung Surgery**

For individuals with scheduled lung surgery for volume reduction, transplantation, or resection who receive a single course of outpatient PR, the evidence includes RCTs and observational studies. Relevant outcomes are symptoms, functional outcomes, and quality of life. There is a lack of large RCTs comparing PR with no PR for preoperative candidates undergoing lung volume reduction surgery (LVRS), lung transplantation, or lung cancer resection. Moreover, the available studies have evaluated exercise programs, but not necessarily comprehensive PR programs. In addition, the few small RCTs and observational studies have reported short-term outcomes and inconsistent evidence of benefit even on these outcomes. The evidence is insufficient to determine the effects of the technology on health outcomes.

**PR After Lung Surgery**

For individuals who have had LVRS who receive a single course of outpatient PR, the evidence includes a case series. Relevant outcomes are symptoms, functional outcomes, and quality of life. No published RCTs were identified. The case series evaluated a comprehensive PR program after LVRS in 49 patients who had not received preoperative PR. Health-related quality of life was higher at 3 to 6 months and at 12 to 18 months postsurgery. The series did not provide data on patients who underwent LVRS and did not have postoperative PR, or patients who had preoperative PR. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who have had lung transplantation who receive a single course of outpatient PR, the evidence includes RCTs, systematic reviews, and observational studies. Relevant outcomes are symptoms, functional outcomes, and quality of life. Neither of the 2 RCTs identified in a 2010 systematic review reported functional outcomes, but uncontrolled studies have 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 post-discharge than before and had a significantly greater 6-minute walk distance (6MWD). Findings on other outcomes were mixed. The most recent RCT (2017) did not identify a difference in outcomes with longer duration of PR. Case series data also support improvements in 6MWD after postoperative PR. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who have had lung cancer resection who receive a single course of outpatient PR, the evidence includes 1 RCT. Relevant outcomes are symptoms, functional outcomes, and quality of life. One small RCT have evaluated a comprehensive PR 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. The evidence is insufficient to determine the effects of the technology on health outcomes.

**Repeat or Maintenance Rehabilitation**

For individuals who have had an initial course of PR who receive repeat or maintenance outpatient PR, the evidence includes RCTs. Relevant outcomes are symptoms, functional outcomes, and quality of life. There are only a few RCTs and many of them have methodologic limitations and/or did not report clinically significant outcomes. The evidence is insufficient to determine the effects of the technology on health outcome.

**Home-Based Rehabilitation**

For individuals who have an indication for outpatient PR who receive a single course of home-based PR, the evidence includes RCTs and systematic reviews. Relevant outcomes are symptoms, functional outcomes, and quality of life. Most studies of home-based PR have compared outcomes with standard care. Very few have compared home-based PR with hospital- or clinic-based PR, and the available studies are mostly of low quality. The evidence is insufficient to determine the effects of the technology on health outcome.

## **Supplemental Information Practice Guidelines and Position Statements**

### **American Thoracic Society and European Respiratory Society**

A 2013 joint statement on PR was issued by the American Thoracic Society (ATS) and the European Respiratory Society (ERS). The statement included the following relevant conclusions:

- “PR provided to patients with respiratory disease other than COPD has demonstrated improvement in respiratory symptoms, exercise tolerance and quality of life.”
- “Symptomatic individuals with COPD who have lesser degrees of airflow limitation who participate in rehabilitation derive similar improvements in symptoms, exercise tolerance and quality of life as do those with more severe disease.”
- “Appropriately resourced home-based exercise training has proven effective at reducing dyspnea and increasing exercise performance in patients with COPD.”

### **British Thoracic Society**

A 2013 guideline on PR in adults by the British Thoracic Society includes the following recommendations:

- PR should be offered to patients with COPD to improve exercise capacity, dyspnea, health status and psychological wellbeing.
- PR programs of 6 to 12 weeks in duration are recommended. A minimum of 12 supervised sessions are recommended, although some patients may gain benefit from fewer sessions.
- If considering a home-based program, the following factors need careful consideration: patient selection, means of providing remote support and/or supervision and provision of home exercise equipment.

A 2011 joint guideline on management of COPD was issued by the American College of Physicians, the American College of Chest Physicians (ACCP), ATS, and ERS: The guideline recommends that “clinicians should prescribe pulmonary rehabilitation for symptomatic patients with an FEV [forced expiratory volume] <50% predicted (Grade: strong recommendation, moderate-quality evidence). Clinicians may consider pulmonary rehabilitation for symptomatic or exercise-limited patients with an FEV >50% predicted (Grade: weak recommendation, moderate-quality evidence).”

In 2007, a joint guideline on PR for COPD and other chronic respiratory diseases was issued by ACCP and the American Association of Cardiovascular and Pulmonary Rehabilitation. The panel issued a number of recommendations. Following are the strong recommendations based on strong (1A) or moderate (1B) evidence:

#### Grade of Recommendation 1A

- A program of exercise training of the muscles of ambulation is recommended as a mandatory component of pulmonary rehabilitation for patients with COPD.
- Pulmonary rehabilitation improves the symptom of dyspnea and improves health-related quality of life in patients with COPD.
- Six to 12 weeks of pulmonary rehabilitation produces benefits in several outcomes that decline gradually over 12 to 18 months.



- Both low- and high-intensity exercise training produce clinical benefits for patients with COPD. Unsupported endurance training of the upper extremities is beneficial in patients with COPD and should be included in pulmonary rehabilitation programs.

#### Grade of Recommendation 1B

- Lower-extremity exercise training at higher exercise intensity produces greater physiologic benefits than lower-intensity training in patients with COPD. The scientific evidence does not support the routine use of inspiratory muscle training as an essential component of pulmonary rehabilitation.
- Education should be an integral component of pulmonary rehabilitation. Education should include information on collaborative self-management and prevention and treatment of exacerbations.
- PR is beneficial for some patients with chronic respiratory diseases other than COPD.

#### **U.S. Preventive Services Task Force Recommendations**

No U.S. Preventive Services Task Force recommendations related to PR have been identified.

#### **Medicare National Coverage**

In 2007, the Centers for Medicare and Medicaid Services (CMS) affirmed their position that a national coverage determination for PR is not appropriate.

#### **Ongoing and Unpublished Clinical Trials**

Some currently unpublished trials that might influence this review are listed in Table 3.

**Table 3. Summary of Key Trials**

<b>NCT No.</b>	<b>Trial Name</b>	<b>Planned Enrollment</b>	<b>Completion Date</b>
<b>Ongoing</b>			
NCT03299504	Factors Predicting Success in Lung Transplant Recipients Who Have Participated in the COLTT Program (Daily Intensive Post-hospitalization Rehabilitation): A Retrospective Review	70	Mar 2018
NCT03326089	Short and Long-term Effects of Oxygen Supplemented Pulmonary Rehabilitation in Idiopathic Pulmonary Fibrosis	20	Jun 2018
NCT02823587	Effects of Pulmonary Rehabilitation on Secretion Transport, Inflammation and Respiratory System Strength and Quality of Life in Patients With Bronchiectasis	60	Jul 2018
NCT02426437	Examining Pulmonary Rehabilitation on Discharged COPD Patients	150	Sep 2018
NCT02842463	Use of the 6-minute Stepper Test to Individualise Pulmonary Rehabilitation in Patients With Mild to Moderate Chronic Obstructive Pulmonary Disease	80	Dec 2018
NCT03095859	Post-operative, Inpatient Rehabilitation After Lung Transplant Evaluation: A Feasibility Study	40	May 2019
NCT03244137	Effects of Pulmonary Rehabilitation on Cognitive Function in Patients With Severe to Very Severe Chronic Obstructive Pulmonary Disease	100	Nov 2019
NCT02887521	Pulmonary Rehabilitation Before Lung Cancer Resection	194	Dec 2020
<b>Unpublished</b>			
NCT02614300	The Role of Pulmonary Rehabilitation and Airways Clearance Techniques in the Multidisciplinary Management of Non CF Bronchiectasis	120	Dec 2017 (unknown)

NCT: national clinical trial.

## VII. Important Reminder

The purpose of this Medical Policy is to provide a guide to coverage. This Medical Policy is not intended to dictate to providers how to practice medicine. Nothing in this Medical Policy is intended to discourage or prohibit providing other medical advice or treatment deemed appropriate by the treating physician.

Benefit determinations are subject to applicable member contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control.

This Medical Policy has been developed through consideration of the medical necessity criteria under Hawaii's Patients' Bill of Rights and Responsibilities Act (Hawaii Revised Statutes §432E-1.4), generally accepted standards of medical practice and review of medical literature and government approval status. HMSA has determined that services not covered under this Medical Policy will not be medically necessary under Hawaii law in most cases. If a treating physician disagrees with HMSA's determination as to medical necessity in a given case, the physician may request that HMSA reconsider the application of the medical necessity criteria to the case at issue in light of any supporting documentation.

## VIII. References

1. Spruit MA, Singh SJ, Garvey C, et al. An official American Thoracic Society/European respiratory society statement: key concepts and advances in pulmonary rehabilitation. *Am J Respir Crit Care Med.* Oct 15 2013;188(8):e13-64.
2. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Pulmonary rehabilitation for patients with chronic obstructive pulmonary disease. TEC Assessments. 1996; Volume 11, Tab 4.
3. Puhan M, Gimeno-Santos E, Scharplatz M, et al. Pulmonary rehabilitation following exacerbations of chronic obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2011(10):CD005305.
4. McCarthy B, Casey D, Devaney D, et al. Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2015;2:CD003793.
5. Rugbjerg M, Jepsen UW, Jorgensen KJ, et al. Effectiveness of pulmonary rehabilitation in COPD with mild symptoms: a systematic review with meta-analyses. *Int J Chron Obstruct Pulmon Dis.* 2015;10:791-801.
6. Roman M, Larraz C, Gomez A, et al. Efficacy of pulmonary rehabilitation in patients with moderate chronic obstructive pulmonary disease: a randomized controlled trial. *BMC Fam Pract.* 2013; 14:21.
7. Gottlieb V, Lyngso AM, Nybo B, et al. Pulmonary rehabilitation for moderate COPD (GOLD 2)--does it have an effect? *COPD.* Oct 2011;8(5):380-386.
8. Liu X-D, Jin H-Z, Ng B-P, et al. Therapeutic effects of gongxi in patients with COPD: a randomized controlled trial. *Hong Kong J Occup Ther.* 2012;22(1):38-46.
9. van Wetering CR, Hoogendoorn M, Mol SJ, et al. Short- and long-term efficacy of a community-based COPD management programme in less advanced COPD: a randomised controlled trial. *Thorax.* Jan 2010;65(1):7-13.

10. Jackson RM, Gomez-Marin OW, Ramos CF, et al. Exercise limitation in IPF patients: a randomized trial of pulmonary rehabilitation. *Lung*. Jun 2014; 192(3):367-376.
11. Gaunaurd IA, Gomez-Marin OW, Ramos CF, et al. Physical Activity and Quality of Life Improvements of Patients with Idiopathic Pulmonary Fibrosis Completing a Pulmonary Rehabilitation Program. *Respir Care* Dec 2014;59(12):1872-1879.
12. Lee AL, Hill CJ, McDonald CF, et al. Pulmonary rehabilitation in individuals with non-cystic fibrosis bronchiectasis: a systematic review. *Arch Phys Med Rehabil*. Jun 16 2016.
13. Fishman A, Martinez F, Naunheim K, et al. A randomized trial comparing lung-volume-reduction surgery with medical therapy for severe emphysema. *N Engl J Med*. 2003; 348(21):2059-2073.
14. Hoffman M, Chaves G, Ribeiro-Samora GA, et al. Effects of pulmonary rehabilitation in lung transplant candidates: a systematic review. *BMJ Open*. Feb 03 2017;7(2):e013445.
15. Morano MT, Araujo AS, Nascimento FB, et al. Preoperative Pulmonary Rehabilitation Versus Chest Physical Therapy in Patients Undergoing Lung Cancer Resection: A Pilot Randomized Controlled Trial. *Arch Phys Med Rehabil*. Jan 2013;94(1):53-58.
16. Benzo R, Wigle D, Novotny P, et al. Preoperative pulmonary rehabilitation before lung cancer resection: Results from two randomized studies. *Lung Cancer*. 2011; 74(3):441-445.
17. Bradley A, Marshall A, Stonehewer L, et al. Pulmonary rehabilitation programme for patients undergoing curative lung cancer surgery. *Eur J Cardiothorac Surg*. Oct 2013; 44(4):e266-271.
18. Beling J. Improved health-related quality of life after lung volume reduction surgery and pulmonary rehabilitation. *Cardiopulm Phys Ther J*. Sep 2009;20(3):16-22.
19. Munro PE, Holland AE, Bailey M, et al. Pulmonary rehabilitation following lung transplantation. *Transplant Proc*. Jan-Feb 2009; 41(1):292-295.
20. Wickerson L, Mathur S, Brooks D. Exercise training after lung transplantation: a systematic review. *J Heart Lung Transplant*. May 2010;29(5):497-503.
21. Langer D, Burtin C, Schepers L, et al. Exercise training after lung transplantation improves participation in daily activity: a randomized controlled trial. *Am J Transplant*. Jun 2012; 12(6):1584-1592.
22. Fuller LM, Button B, Tarrant B, et al. Longer versus shorter duration of supervised rehabilitation after lung transplantation: a randomized trial. *Arch Phys Med Rehabil*. Feb 2017;98(2):220-226.e223. PMID 27697429
23. Stigt JA, Uil SM, van Riesen SJ, et al. A randomized controlled trial of postthoracotomy pulmonary rehabilitation in patients with resectable lung cancer. *J Thorac Oncol*. Feb 2013; 8(2):214-221. PMID 23238118
24. Edvardsen E, Skjonsberg OH, Holme I, et al. High-intensity training following lung cancer surgery: a randomized controlled trial. *Thorax*. Mar 2015;70(3):244-250.
25. Carr SJ, Hill K, Brooks D, et al. Pulmonary rehabilitation after acute exacerbation of chronic obstructive pulmonary disease in patients who previously completed a pulmonary rehabilitation program. *J Cardiopulmon Rehab Prev*. 2009; 29(5):318-324.
26. Health Quality Ontario. Ontario Health Technology Assessment Series: Pulmonary rehabilitation for patients with chronic pulmonary disease (COPD): An evidence-based analysis. 2012;

[http://www.hqontario.ca/en/mas/tech/pdfs/2012/rev COPD Pulmonary Rehab Marc h.pdf](http://www.hqontario.ca/en/mas/tech/pdfs/2012/rev_COPD_Pulmonary_Rehab_Marc_h.pdf); Accessed February 16, 2017.

27. Guell MR, Cejudo P, Ortega F, et al. Benefits of long-term pulmonary rehabilitation maintenance program in patients with severe chronic obstructive pulmonary disease. three-year follow-up. *Am J Respir Crit Care Med*. Mar 01 2017;195(5):622-629.
28. Wilson AM, Browne P, Olive S, et al. The effects of maintenance schedules following pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a randomised controlled trial. *BMJ Open*. 2015;5(3):e005921.
29. Liu XL, Tan JY, Wang T, et al. Effectiveness of Home-Based Pulmonary Rehabilitation for Patients with Chronic Obstructive Pulmonary Disease: A Meta-Analysis of Randomized Controlled Trials. *Rehabil Nurs*. Jan-Feb 2014;39(1):36-59.
30. Vieira D, Maltais F, Bourbeau J. Home-based pulmonary rehabilitation in chronic obstructive pulmonary disease patients. *Curr Opin Pulm Med*. 2010; 16(2):134-143.
31. Neves LF, Reis MH, Goncalves TR. Home or community-based pulmonary rehabilitation for individuals with chronic obstructive pulmonary disease: a systematic review and meta-analysis. *Cad Saude Publica*. Jun 20 2016;32(6).
32. Maltais F, Bourbeau J, Shapiro S, et al. Effects of home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a randomized trial. *Ann Intern Med*. 2008; 149(12):869-878.
33. Bolton CE, Bevan-Smith EF, Blakey JD, et al. British Thoracic Society guideline on pulmonary rehabilitation in adults. *Thorax*. Sep 2013; 68 Suppl 2:ii1-30. PMID 23880483
34. Qaseem A, Wilt TJ, Weinberger SE, et al. Diagnosis and management of stable chronic obstructive disease: A clinical practice guideline update from the American College of Physicians, American College of Chest Physicians, American Thoracic Society, and the European Respiratory Society. *Ann Intern Med*. 2011; 155(3):179-191.
35. Ries AL, Bauldoff GS, Carlin BW, et al. Pulmonary rehabilitation: joint ACCP/AACVPR evidence-based clinical practice guidelines. *Chest*. 2007; 131(5 suppl):4S-42S.
36. BlueCross BlueShield Association. Outpatient pulmonary rehabilitation. Medical Policy Reference Manual. 8.03.05. Last reviewed March 2018.