Lung Transplantation and Exercise

Indexing Metadata/Description

› Title/condition: Lung Transplantation and Exercise
› Synonyms: Exercise and lung transplantation; transplantation, lung and exercise; lung transplantation and pulmonary rehabilitation; pulmonary rehabilitation and lung transplantation
› Anatomical location/body part affected: Lung/pulmonary system
› Area(s) of specialty: Pulmonary rehabilitation
› Description
  • Single or double lung transplantation (LTx) is a surgical intervention for patients with chronic respiratory failure (i.e., severe hypoxemia and hypercapnia) resulting from severe cystic fibrosis, obstructive lung diseases (e.g., bronchiolitis obliterans, bronchiectasis), primary pulmonary hypertension, and restrictive lung diseases (e.g., idiopathic pulmonary fibrosis, desquamative interstitial fibrosis, systemic sclerosis/scleroderma, collagen vascular disease, asbestosis, eosinophilic granuloma, and sarcoidosis)
  • LTx is reserved for qualified candidates with stage IV lung disease based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) severity scale. Stage IV criteria include shortness of breath on mild exertion, right heart failure, cyanosis (i.e., bluish skin, nails, and lips), and forced expiratory volume in 1 second (FEV1) less than 30% of predicted
  • In addition, candidates are usually on long-term oxygen therapy, limited to chair or bed rest, and unable to carry out any physical activity without discomfort
  • The main goal of LTx is return of the patient to a functional lifestyle with optimized physical capacity for activities of daily living (ADLs)
  • Successful LTx improves pulmonary function tests (PFTs) and functional ability. However, most transplant recipients continue to have lower functional exercise capacity than healthy people their age, likely because of atrophy and deconditioning that occur during extended physical inactivity both before and after LTx
  • Resumption of usual ADLs after LTx does not reliably normalize exercise capacity
  • Strong evidence supports supervised aerobic and/or resistance exercise training after LTx for improving functional exercise capacity consistent with health-related quality of life (HRQoL)
  • Guidelines are available for pulmonary rehabilitation exercise training, as well as for the role of physical therapy, in the management of patients with chronic severe pulmonary disease
  • This Clinical Review focuses on the potential for supervised exercise training to restore normal functional capacity and promote HRQoL after LTx
› ICD-9-CM codes
  • V42.6 lung replaced by transplant
  • V58.44 aftercare following organ transplant
› ICD-10-CM code
  • Z94.2 (will replace ICD-9-CM V42.6 in the United States after October 1, 2014)

(ICD codes are provided for the reader’s reference only, not for billing purposes)
G-Codes

• Mobility G-code set
  – G8978, Mobility: walking & moving around functional limitation, current status, at therapy episode outset and at reporting intervals
  – G8979, Mobility: walking & moving around functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  – G8980, Mobility: walking & moving around functional limitation, discharge status, at discharge from therapy or to end reporting

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<td>At least 1 percent but less than 20 percent impaired, limited or restricted</td>
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<tr>
<td>CN</td>
<td>100 percent impaired, limited or restricted</td>
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Source: http://www.cms.gov

Reimbursement: Reimbursement for therapy will depend on insurance contract coverage; no specific special agencies are applicable for this condition. No specific issues or information regarding reimbursement have been identified.

Presentation/signs and symptoms

• Presentation specifically for pulmonary rehabilitation exercise training
• Inadequate physical fitness, especially lower-extremity strength and cardiorespiratory endurance, for achieving personal lifestyle goals
• Thoracic scars characteristic of LTx
• Limited upper body range of motion (ROM), most notable in the first 10 weeks following LTx
• Resting heart rate (HR) and blood pressure (BP) might be somewhat elevated due to prolonged physical inactivity
• Post-LTx complications include
  – persistent cough
  – increasing dyspnea
  – fatigue
• Adverse symptoms of immunosuppressive therapy that include
  – muscle weakness
  – fatigue
  – increased hair growth
  – bruising
  – hypertension

Causes, Pathophysiology, & Risk Factors

Potential causes of reduced functional capacity post LTx: Although successful LTx significantly improves pulmonary function, peak exercise capacity remains 40-60% below predicted for age. This is possibly because of

• general deconditioning after prolonged illness and physical inactivity
- muscle weakness
  - Disuse atrophy
  - Insufficient strength and power to perform at age-norm on exercise testing. For example, improvement in 6-minute walk for distance test (6MWT) after LTx was delayed by slow recovery of quadriceps strength rather than pulmonary function(32)

- impaired aerobic fitness (decreased muscle blood flow and oxygen utilization)
- reduced peak oxygen consumption (VO$_2$peak) at maximal exercise

• In a minority of cases, the mechanics of lung ventilation remains abnormal due to
  - bronchiolitis obliterans (i.e., chronic pulmonary graft rejection)
  - restrictive chest wall function
  - pulmonary denervation

### Pathophysiology (3,6,7,12,13,14,15)

• Reduced muscle strength and cardiovascular function after LTx
  - Skeletal muscle deconditioning is indicated by decreased
    - lower-extremity strength(32)
    - muscle mass
    - mitochondrial density
    - enzyme capacity for oxidative/aerobic metabolism
  - Cardiovascular deconditioning is indicated by
    - elevated HR at rest and during submaximal work
    - low stroke volume (SV) at rest and during submaximal work
    - elevated systolic BP at rest and during submaximal work
    - impaired vasodilatation with decreased muscle perfusion

• Decreased O$_2$ delivery to active muscles and decreased O$_2$ utilization reduces VO$_2$peak at maximal exercise
• HR and BP responses to graded submaximal exercise resemble the age-norm for sedentary, unfit individuals

### Risk factors for poor functional capacity continuing after LTx

• Noncompliance with therapeutic regimen, including$^{(16)}$
  - smoking
  - inadequate daily physical activity
  - dietary habits that might promote obesity, diabetes, or hyperlipidemia
  - abuse of alcohol or drugs

• Adverse effects of immunosuppressive therapy, such as calcineurin antagonist drugs$^{(17,33)}$
  - Corticosteroid-induced myopathy$^{(12)}$

• Continuing sedentary lifestyle/inadequate daily physical activity$^{(13)}$

### Overall Contraindications/Precautions

• Immunosuppressive medications help prevent rejection of the transplanted lung; however, they increase susceptibility to infection and various types of cancer. Clinicians should remain alert for new infections and postpone exercise during active infection. Calcineurin antagonists might attenuate the improvement of cardiorespiratory fitness and muscle strength with training$^{(17,33)}$

• Notify physician immediately if patient presents with recent onset of signs and symptoms of acute illness (e.g., unusual fatigue, fever, chills, headache, dizziness, nausea, diarrhea)

• The most common complications found in patients after LTx are arterial hypertension, chronic renal insufficiency, hyperlipidemia, diabetes, and osteoporosis$^{(18)}$

• Postpone physical activity/exercise therapy and notify physician if$^{(19)}$
  - resting systolic BP exceeds 200 mmHg
  - resting diastolic BP exceeds 110 mmHg
  - symptoms such as severe headache, dizziness, or lightheadedness occur during exercise
  - fatigue resolves very slowly after exercise

• Gastroesophageal reflux disease (GERD) after LTx increases the risk of aspiration
Treatment with immunosuppressants and glucocorticoids after LTx and prolonged bed rest increase the risk of developing osteoporosis and osteoporosis-related fracture. Exercises should be modified for patients with osteoporosis. For example, avoid exercises that involve forward trunk flexion in patients with known vertebral compression fracture.

See specific Contraindications/precautions to examination and Contraindications/precautions under Assessment/Plan of Care.

**Examination**

Contraindications/precautions to examination

- Stop the exam and notify physician if patient reports chest pain, shortness of breath, or dizziness
- Prescription of the patient’s target exercise HR to control training intensity is ideally based on the results of preliminary graded exercise testing. Commonly, an exercise testing protocol is administered on a treadmill or bicycle ergometer
- If an incremental exercise test on a treadmill or cycle ergometer is used to assess the patient’s response to exertion, follow guidelines for test administration and termination.

**History**

- History of present illness
  - Mechanism of injury or etiology of illness: What pulmonary disease required LTx for this patient? Document date and stage of lung disease at surgery. Were one lung or both lungs removed?
  - Course of treatment
    - Medical management: Is the patient being treated for any complications related to LTx (e.g., arterial hypertension, chronic renal insufficiency, hyperlipidemia, diabetes, osteoporosis)? Is supplemental portable oxygen prescribed? Which of the modifiable risk factors listed above have been addressed?
    - Surgical management: How long was patient on waiting list? Were there any complications of surgery or anesthesia (e.g., breathing problem, infection, bleeding, reaction to medications, diabetes)? Is the patient compliant with postoperative instructions?
  - Medications
    - Determine what medications have been prescribed. Document adherence to medication regimen
    - Lifelong daily immunosuppressive medication is required to prevent rejection. Most patients are treated with triple therapy: a combination of a calcineurin inhibitor (cyclosporine A or tacrolimus), an antimetabolite agent (azathioprine [Imuran] or mycophenolate mofetil), and a corticosteroid
    - Other immunosuppressive treatments that might be used include radiation and plasmapheresis
  - Diagnostic tests completed: Postoperative laboratory workup usually includes the following:
    - PFTs
    - Electrocardiogram (ECG)
    - Complete blood count (CBC)
    - Blood glucose
    - Serum potassium, creatinine, and calcium
    - Hematocrit
    - Lipid profile
    - Optional – urinary albumin/creatinine ratio or urinary albumin excretion
  - Alternative therapies: Document any use of herbal, behavioral, or other therapies such as massage, and whether or not they help
  - Previous therapy: Document whether patient has received preoperative/post-LTx education. Did patient receive in-hospital physical therapy and, if so, what specific treatments were helpful or not helpful?
  - Aggravating/easing factors (and length of time each item is performed before the symptoms come on or are eased)
  - Body chart: Use body chart to document location and nature of symptoms
  - Nature of symptoms: Document reported symptoms
  - Rating of symptoms: Use a visual analog scale (VAS) or 0-10 scale to assess symptoms at their best, at their worst, and at the moment
  - Pattern of symptoms: Document changes in symptoms throughout the day and night, if any (A.M., mid-day, P.M., night); also document changes in symptoms due to weather or other external variables
  - Sleep disturbance: If present, document number of wakings/night
Other symptoms: Document other symptoms patient might be experiencing that could exacerbate the condition and/or symptoms that could be indicative of a need to refer to physician (e.g., dizziness, bowel/bladder/sexual dysfunction, saddle anesthesia)

Barriers to learning
- Are there any barriers to learning? Yes__ No__
- If Yes, describe ____________________________

Medical history
– Past medical history
  - Previous history: Any prior exercise therapy for chronic conditions?
  - Comorbid diagnoses: Any history of hypertension, heart disease, stroke, kidney disease, diabetes, or other chronic disease?
  - Medications previously prescribed: Obtain a comprehensive list of all prescribed and over-the-counter medications, herbal remedies, and use of illegal street drugs
  - Other symptoms: Ask patient about other symptoms he or she might be experiencing

Social/occupational history
– Patient’s goals: Document what the patient hopes to accomplish with therapy (patient-oriented outcomes)
– Vocation/avocation and associated repetitive behaviors, if any: Does the patient want to participate in recreational sports? Any recent changes in weight, physical activity, diet, smoking, or use of caffeine and alcohol?
– Functional limitations/assistance with ADLs/adaptive equipment: If applicable
– Psychosocial and environmental factors: Ask about family situation, employment status, and working conditions that might increase stress/anxiety

Relevant tests and measures: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting)
• Anthropometric characteristics: Determine height, weight, and body mass index (BMI). Is weight loss or weight gain indicated?
• Assistive and adaptive devices: Assess fit and use of prescribed assistive devices, if applicable. Is an ambulatory assistive device needed for safe walking? Is the patient ambulatory but uses a wheelchair for energy conservation?
• Balance: Assess static and dynamic balance reactions in order to determine whether a patient is safe to use exercise equipment such as treadmill or elliptical trainer that might require normal balance. Measure with Berg Balance Scale, as indicated
• Cardiorespiratory function and endurance
  – Assess HR, BP, and respiratory rate (RR) during quiet rest. Auscultate lung sounds for abnormalities. If indicated, review results of PFTs after LTx to ensure adequate pulmonary function for exercise
  – The 6MWT is commonly used in pulmonary rehabilitation to assess functional endurance capacity and as an objective outcome measure.6MWT distance and speed averaged 898 ft +/- 372 ft (standard deviation [SD]) and 0.84 m/sec +/- 0.30 m/sec SD, respectively, in 129 patients awaiting LTx at an urban transplant center
  – The Borg Rating of Perceived Exertion (RPE) Scale can be used to monitor patient’s intensity during 6MWT
• Circulation: Assess carotid pulse and peripheral pulses in all limbs
• Functional mobility: Assess gross movement during transfers and functional tasks using the upper extremities (e.g., reaching, pulling, pushing, holding, etc.) and lower extremities (e.g., stair climbing, squatting, kneeling, kicking). Administer Functional Independence Measure (FIM), as indicated
• Gait/locomotion: Assess gait, including synchrony of limb movements and usual walking speed, as well as posture in walking. Administer Dynamic Gait Index (DGI) to assess gait safety, as indicated
• Joint integrity and mobility: Ensure joint flexibility is functional for the planned exercise program
• Muscle strength: Assess strength in physical tasks (e.g., handgrip, pushing, pulling, sit-up, squatting). Assess strength in muscle groups targeted for exercise training using manual muscle testing (MMT), dynamometry, or machine weights
• Observation/inspection/palpation: Ensure that surgical scars are healed. Inspect for physical deformities that might require modifying the exercise program
• Pain/tenderness/fatigue: Assess for general pain and fatigue during exercise testing
• Range of motion: Assure that functional ROM is present for planned exercise program and use of exercise equipment
• Reflexes: Assess deep tendon reflexes
• Sensation: Scan for sensation to touch
• **Special test specific to diagnosis**
  – Graded exercise test: Monitor the patient’s HR, BP, RR, and RPE during progressive submaximal exercise on a cycle ergometer or treadmill for the purpose of individualized aerobic exercise prescription.\(^{(19)}\) Follow guidelines for test monitoring and termination\(^{(21-22)}\)

**Assessment/Plan of Care**

› **Contraindications/precautions**
  • Tailor the exercise program to fit each patient’s functional capacity and cardiorespiratory responses to monitored exercise (e.g., 6MWT or graded exercise testing)\(^{(19)}\)
  • Ideally, the exercise training HR and BP should be prescribed on the basis of preliminary exercise testing. Cardiopulmonary responses to graded exercise testing after LTx are generally similar to the age norm for sedentary, unfit individuals\(^{(8)}\)
  • Monitor HR and BP on a regular basis during exercise to ensure they remain within acceptable limits for the patient
  • According to standard guidelines, the exercise session should be stopped and the physician notified if
    – systolic BP exceeds 260 mmHg or diastolic BP exceeds 115 mmHg
    – systolic BP falls more than 10 mmHg below previous reading despite continuing exercise
    – exertional symptoms such as chest discomfort, palpitations, lightheadedness, or shortness of breath indicate distress
  • BP higher than 180/110 mmHg is an absolute contraindication and BP higher than 160/100 mmHg is a relative contraindication for starting a resistance exercise session\(^{(22)}\)
  • An exaggerated BP response to exercise might be prevented by giving the patient a thorough orientation to the use of the prescribed exercise equipment and adequate time to warm-up\(^{(23)}\)
  • In addition to monitoring HR, BP, and RPE to manage exercise training intensity, use VAS to rate other symptoms that are reported\(^{(19)}\)
  • Extend the cooling-down period and avoid having the patient stop suddenly after exercise because this might cause a precipitous fall in systolic BP due to venous pooling (i.e., orthostatic hypotension) to prevent syncope
  • Clinicians should follow the exercise guidelines of their clinic/hospital and what is ordered by the patient’s physician
  • Electrotherapeutic modalities are indicated for patients after LTx only when prescribed by the referring physician for coexisting conditions
  • Rehabilitation professionals should always use their professional judgment regarding the use of modalities

› **Diagnosis/need for treatment:** Status post LTx/reduced functional capacity secondary to lower-extremity weakness and cardiopulmonary deconditioning; hypokinetic lifestyle that might contribute to medical complications and reduced HRQoL

› **Rule out:** Arterial hypertension, chronic renal insufficiency, hyperlipidemia, diabetes, osteoporosis, diabetes mellitus, and coronary artery disease

› **Prognosis:** Long-term survival and functional outcomes after LTx have steadily improved despite numerous problems and complications that can develop, including chronic tissue rejection.\(^{(24)}\) Five years after lung transplantation, 1 in 5 transplant recipients develop cancers or have heart problems however, most patient demonstrate an improvement in quality of life and patients are able to do more activities on a daily basis.\(^{(36)}\)
  • Patients after LTx generally have an increase in peak exercise capacity and improvements in their heart rate reserve function as a result of an increase in exercise capacity\(^{(27)}\)

› **Referral to other disciplines:** Physician for adverse effects of immunosuppressive therapy; respiratory therapist for pulmonary function testing/rehabilitation; nutritionist for dietary therapy and advice on weight control; occupational therapist for limitations in ADLs; psychiatrist/psychologist for stress/anxiety disorder

› **Other considerations**
  • Standard chest physical therapy is routinely used to expand the lungs and remove secretions in acute care after LTx. High-frequency chest wall oscillation might be less painful and preferable to chest physical therapy for inpatients after double LTx\(^{(35)}\)
  • Although physical function and HRQoL improve after LTx, a high percentage of patients choose not to return to work\(^{(25)}\)
  • Continuing patient education is necessary after LTx for recipients to gain sufficient knowledge and adequate self-management skills in the long term\(^{(26)}\)
Lower-extremity strength training in early-outpatient (phase 2) rehabilitation appears safe and effective for restoring functional capacity after LTx.(22)

**Treatment summary:** Muscle weakness with impaired aerobic capacity at the cellular level, as opposed to pulmonary function, typically limit exercise capacity after LTx.\(^{(12-28,29,32)}\) For example, in 153 patients who underwent cardiopulmonary exercise testing within 30 months before and after LTx, VO2peak increased only 19% despite improvements in FEV1 and maximum voluntary ventilation of 136% and 91%, respectively.\(^{(29)}\) The research findings strongly suggest a peripheral limitation,\(^{(5,6,7,12,13,14,15)}\) with particular involvement of the quadriceps muscle group.\(^{(6,7,28,32)}\)

Combined resistance and aerobic exercise training, especially lower-extremity reconditioning, is thus indicated for post-LTx rehabilitation:

- **Aerobic exercise training**\(^{(3,8,9,19,22)}\)
  - Type of activity: Rhythmic movement with the legs (e.g., walking, jogging, or cycling), arms (e.g., upper body cycle ergometer), or both legs and arms (e.g., elliptical trainer with arm levers)
  - Intensity: “Moderate” exertion, equaling 11 to 13 on the Borg RPE Scale (6 to 20)\(^{(19)}\)
  - Duration: Continuous or discontinuous exercise totaling 30 to 60 min of continuous or intermittent physical activity per day. Preferably, more than 5 hours per week for overweight individuals in a weight-loss regimen
  - Frequency: Most, preferably all days of the week

- **Resistance exercise training**
  - Systematic reviews indicate that moderate-intensity dynamic weight lifting, preferably on machines, 2 or more nonconsecutive days per week is effective for improving strength after LTx\(^{(3,8,9,12)}\)
  - Type of activity: weight-lifting exercises on machines or using free-weights (e.g., leg press, chest press, leg extension, lat pull-down, leg curls, shoulder press, biceps curl, triceps press)
  - Intensity: 65% of 10-repetition maximum for each exercise
  - Duration: 2-3 sets of 10 repetitions per exercise, taking about 30 min to complete the workout
  - Frequency: 2-3 nonconsecutive days per week

- **A general physical reconditioning exercise program** (3 days/wk, 12 weeks) after LTx improved 6-minute walk distance\(^{(2)}\)

  Based on a randomized controlled trial in Belgium, supervised exercise training initiated immediately after hospital discharge for LTtx might improve voluntary daily walking time, physical fitness, HRQoL, and cardiovascular morbidity\(^{(30)}\)

  - The exercise group (EG, n=18) participated in a 3-month supervised program. At 1-year follow-up, individuals in the EG walked significantly more in daily activities than the controls (n=16): 85 vs. 54 min/day
  - Individuals in the EG also had significantly higher quadriceps strength, 6MWTscores, and self-reported physical functioning, as well as lower mean 24-hour ambulatory BP, than the controls at 1-year follow-up

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<tr>
<th>Problem</th>
<th>Goal</th>
<th>Intervention</th>
<th>Expected Progression</th>
<th>Home Program</th>
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<tbody>
<tr>
<td>Reduced strength, aerobic endurance, and functional exercise capacity</td>
<td>Improvement of functional exercise capacity to age-norm or better</td>
<td><strong>Exercise therapy</strong></td>
<td>Gradually progress the intensity and duration of exercise to the maintenance phase</td>
<td>Provide the patient with an independent home program at discharge from supervised exercise. Physical fitness can continue to improve with an ongoing progressive exercise program after transplantation(^{(31)})</td>
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\(^{(22)}\) The research findings strongly suggest a peripheral limitation, with particular involvement of the quadriceps muscle group.

\(^{(30)}\) Based on a randomized controlled trial in Belgium, supervised exercise training initiated immediately after hospital discharge for LTtx might improve voluntary daily walking time, physical fitness, HRQoL, and cardiovascular morbidity.
Desired Outcomes/Outcome Measures

- Desired outcomes/outcome measures
  - Improved strength
    - MMT, use of exercise machines, or free weights
    - Graded exercise testing\(^{(19)}\)
  - Improved aerobic endurance
    - 6MWT\(^{(20)}\)
  - Improved functional exercise capacity
  - Improved HRQoL
    - SF-36 Health Survey questionnaire

Maintenance or Prevention

- Continue prescribed exercise training using an independent home exercise program
- Weight reduction and control, as indicated
- Dietary program, as prescribed

Patient Education


Note

- Recent review of the literature has found no updated research evidence on this topic since previous publication on January 16, 2015

Coding Matrix

References


