



Department of Rehabilitation Services

Standard of Care: Inpatient Physical Therapy Management of the Patient Status Post Cardiac Transplantation

ICD-10 Codes:

I50 Heart failure:

- I50.1 Left ventricular Failure
- I50.2 Systolic (congestive) heart failure
- I50.3 Diastolic (congestive) heart failure
- I50.4 Combined systolic (congestive) and diastolic (congestive) heart failure
- I50.9 Heart failure, unspecified

I42 Cardiomyopathy

- I42.0 Dilated cardiomyopathy
- I42.1 Obstructive hypertrophic cardiomyopathy
- I42.2 Other hypertrophic cardiomyopathy
- I42.3 Endomyocardial (eosinophilic) disease
- I42.4 Endocardial fibroelastosis
- I42.5 Other restrictive cardiomyopathy
- I42.6 Alcoholic cardiomyopathy
- I42.7 Cardiomyopathy due to drug and external agent
- I42.8 Other cardiomyopathies
- I42.9 Cardiomyopathy, unspecified

T86.2 Complication(s) of transplant- heart

Case Type / Diagnosis:

This standard of care applies to patients who are status post a primary orthotopic cardiac transplantation. An orthotopic heart transplant is a procedure in which the person's native heart is removed and replaced with a donor/allograft heart. Another technique less commonly used is the heterotopic procedure, where the donor heart is placed in the chest along with the patient's native heart to assist the native heart's function. This standard of care also includes information for patients who have previously undergone cardiac transplantation and are readmitted to the hospital for complications directly related to their transplant, or for unrelated conditions. It is a supplement to the cardiac standard of care and should be used in conjunction with the procedures and precautions outlined in that document.

Heart transplants are indicated for patients who have end-stage heart disease or heart failure, but who are otherwise healthy enough to undergo this surgery. The diseases for which cardiac transplant is indicated can be categorized as follows¹⁹: idiopathic cardiomyopathy (54%),

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ischemic cardiomyopathy (45%), congenital heart disease and other diseases (1%). Patients will specifically have a left ventricular ejection fraction of less than 25% and New York Heart Association (NYHA) class III or IV symptoms to be a candidate for heart transplant.¹⁹

The benefit of transplantation may become apparent if a person is hospitalized and unable to wean from continuous intravenous medications for cardiac support and/or from other medical supports. In unhospitalized patients, the following requirements have been recommended for consideration for cardiac transplantation:

- A history of repeated hospitalizations for heart failure
- Need for ventricular assist device or artificial heart to support circulation
- Increasing types, dosages, and complexity of medications
- A reproducible VO₂ of less than 14 mL/kg per minute¹⁰

If patients meet the above criteria and are interested in pursuing heart transplantation, they are then further evaluated by their medical team to rule out any other diseases or situations which may exclude them from receiving a heart transplant. Diseases which could potentially exclude someone from receiving a heart transplant include cancer, uncontrolled pulmonary hypertension, or infections.¹⁰ Once a patient is deemed a suitable candidate and is listed for a heart transplant, a national organization named UNOS (United Network for Organ Sharing) is involved with managing and matching patients with available organs.^{10,28} The matching of organs is based on many factors including the compatibility of the available organs to the patient, and the patient's level of medical need. Adult heart transplant candidates are assigned to one of four categories: 1A, 1B, 2, or inactive based on their medical status, with status 1A being the patients with the highest medical need for a transplant. There is an ongoing assessment of the patient's status by their medical teams, and a patient's status may change at times.^{25,28}

The prevalence of heart failure in the United States continues to rise, and there are currently 5.7 million adults in the United States who are living with heart failure. As the number of people with end-stage heart failure rises, it is predicted that the number of people listed for heart transplant will also continue to grow. However, there continues to be a significant shortage of hearts available for donation. One area of current research in heart transplantation is attempting to improve the organ procurement and preservation process in the hopes of increasing the number of donor hearts available.¹²

American Heart Association Statistics⁴:

- In 2015, 2,804 heart transplantations were performed in the United States
- Of the recipients in 2015, 71.4% were male; 61.4% were white; 21.6% were black; 11.1% were Hispanic.
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- For transplants that occurred between 2009 and 2010, the 1-year survival rate was 90.8% for males and 90.6% for females; the 5-year rates between 2005 and 2010 were 77.5% for males and 75.6% for females.
- As of May 27, 2016, 4,134 patients were on the transplant waiting list for a heart transplant, and 40 patients were on the list for a heart/lung transplant⁴.

Indications for Treatment:

There are several important reasons for physical therapy following a heart transplant. “Cardiac transplant patients continue to experience exercise intolerance due to extended inactivity and convalescence, associated skeletal muscle derangements, loss of muscle mass and strength, and the absence of autonomic cardiac innervation.”³ In addition, medical treatment with corticosteroids postoperatively often leads to or worsens already existing muscular weakness.

The APTA preferred practice patterns that apply to this population include:

- Impaired aerobic capacity/endurance associated with deconditioning.
- Impaired aerobic capacity/endurance associated with cardiovascular pump dysfunction or failure
- Impaired muscle performance

Contraindications / Precautions for Treatment:

Postoperative Complications

The heart transplant patient may experience postoperative complications including: right heart failure, persistent pulmonary hypertension, renal dysfunction, arrhythmias, bleeding, acute rejection, infection (examples include cytomegalovirus (CMV), pneumocystis carinii (PCP), herpes virus), or psychological disturbances related to steroid therapy.^{18, 19, 26} Initiation of physical therapy may need to be delayed in the ICU until the patient is hemodynamically stable, the patient’s chest is closed, bleeding is controlled, and any other immediate postoperative medical complications have resolved.

Rejection

About two-thirds of patients experience at least one rejection episode in the first post-transplant year, with the greatest risk occurring in the early post-transplant months.¹³

Endomyocardial biopsies are performed routinely to screen for rejection. The biopsies are performed more frequently immediately postoperatively (weekly), and less frequently as time passes, eventually progressing to once a year.

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Signs and symptoms of rejection may include symptoms like the symptoms of heart failure (fatigue, dyspnea, decreased exercise tolerance, hypotension, pericardial friction rub, ventricular S3 gallop, decreased cardiac output, peripheral edema, pulmonary crackles, jugular vein distension, increased temperature, arrhythmias, and/or decreased urinary output). However, the patient often does not have any symptoms.^{13,26}

When rejection is suspected, the patient's immunosuppressive medication dosages may be increased, and biopsies may be performed more frequently. The therapist should be aware of the patient's rejection and subsequent treatments for the rejection, and should modify the patient's activity/exercise program appropriately.

Sternal Precautions

All patients status post heart transplant must adhere to sternal precautions. Refer to the Cardiac Standard of Care document for specific information regarding sternal precautions. Patient education documents regarding sternal precautions are also available within the patient education section of the T-drive: Guidelines After Cardiac Surgery Education. For patient documentation, sternal precautions can be accessed via the Smartphrase: .sternalprecautions

Infection Control Precautions

To protect the heart transplant patient from communicable illness, the following precautions are recommended by the Brigham and Women's Infection Control Department:

- Staff with a fever or upper respiratory infection may not enter the room
- Before entering the room, staff must disinfect their hands with an alcohol-based waterless agent
- Staff will wear gown and gloves to enter the patient's room while the patient is in the ICU
- Staff will use the stethoscope dedicated to the room
- Any shared patient care equipment will be disinfected before use on patient

Denervated heart

Normally the vagus nerve innervates the heart, however during an orthotopic heart transplant procedure the heart becomes denervated and vagal input is impaired. This alters both the resting heart rate as well as the heart rate responses during activity and in response to exercise.

In a normally innervated heart, the vagus nerve at rest provides parasympathetic input which works to lower the intrinsic rate of the heart set by the SA (sinoatrial) node. In the transplanted heart however, the SA node paces the allograft heart resulting in a higher resting heart rate (HR).⁵ The resting rate elevates to approximately 90-110 beats per minute.²⁶

In the newly transplanted heart, the HR response during exercise is mainly controlled by catecholamines from the adrenal glands, resulting in a significantly slower increase of the HR at

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the onset of exercise, a reduced peak HR, and a delayed return towards resting values after the cessation of exercise.^{22, 23} Patients should therefore gradually increase and decrease demands on the transplanted heart by extending their warm-up and cool-down periods to 5-10 minutes.²⁶

Effects of use of steroids/immunosuppressive medications

The heart transplant recipient will always be on immunosuppressive medications to prevent rejection of the donor heart. There are potential side effects of these medications which may include:

- “Systolic and diastolic hypertension may be due to elevated catecholamine levels, the effects of immunosuppressive medications, altered baroreceptor sensitivity, or combinations thereof.”³
- There is a potential for decreased bone density and associated comorbidities. “Significant reduction in bone mineral density (BMD) occurs postoperatively in nearly 100% of heart transplant recipients immunosuppressed with glucocorticoids.”⁵

Effects of use of steroids/immunosuppressive medications

- Potential for the development of diabetes: 15-20% of adult patients will develop diabetes after cardiac transplant.¹⁸
- Steroid myopathies with proximal muscle weakness
- Increased risk for infections³
- Increased tendency to develop lymphoproliferative malignancies²

Orthostatic hypotension:

Orthostatic hypotension is common in the early postoperative phase due to the absence of compensatory reflex tachycardia from cardiac denervation. Position changes should be performed slowly to allow the patient to slowly adapt to the new position.²⁶

Evaluation:**Medical History/Reason for Admission:**

- Patient's preoperative diagnosis including stage of heart failure if applicable
- Onset and duration of symptoms
- Primary admission for initial heart transplant versus readmission for other medical reasons
- Later complications that may result in repeat hospitalizations include, but are not limited to: rejection, infection, development of secondary malignancies, and coronary vasculopathy
- The two most common malignancies to develop in this population of patients are post-transplant lymphoproliferative disorder (PTLD), and skin cancers.¹³

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- Primary surgery for heart failure versus previous VAD
- If patient used a VAD, note length of time spent on the device and type of device

Hospital Course:

- Note any preoperative or postoperative evaluation studies, including but not limited to: results of heart catheterizations, echocardiograms, stress tests, electrocardiograms, and endomyocardial biopsies
- Date of surgery
- Postoperative course including length of time on pressors, length of time intubated, any postoperative complications

Social History:

- Prior functional level including remote versus recent activity tolerance, types of activities the patient enjoys, and the typical frequency and duration of prior activities
- Available home exercise equipment with early discussion regarding the patient's preferences for mode(s) of exercise once they are home
- Available home supports
- Home or community environmental barriers
- Family roles, professional roles and roles within the community

Medications:

Note the patient's current list of medications, including medications related to anti-rejection (i.e.: Cyclosporin, Cellcept, Prednisone) and hemodynamic control. If the patient is in the ICU, also pay most attention to intravenous (IV) medications and reasons for their use. Refer to the cardiac standard of care for further details.

Examination:

Observation:

- Make note of the equipment being used in the patient's room including: intravenous lines and locations, medications infusing, catheters, chest tubes (to suction versus waterseal; mediastinal versus pleural), pulmonary artery (PA) lines, method of oxygen delivery if being used, vital sign monitoring equipment
- Appearance of the patient including body type, cushinoid features or cachexia, areas of atrophy, skin integrity (presence of edema, any areas or potential areas of skin breakdown), tremors, respiratory pattern
- Observe the sternal wound and make note of any areas of redness or swelling, and note the type of closure method and/or dressings being used

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Mental Status:

Evaluate patient's level of alertness, ability to follow motor commands, and level of safety awareness. Also, note any personality changes, such as being emotionally labile or euphoric, which may occur due to the use of steroid treatment postoperatively.

Pain:

Assess pain related to the sternotomy and/or any other area of pain. Use verbal analog (VAS) rating scale for pain assessment. Note that cardiac denervation often prohibits the patient from feeling the sensation of angina.

ROM:

Assess gross range of motion of all extremities; shoulder flexion and abduction should be looked at unilaterally per sternal precautions. Note any limitations in spine mobility related to abnormal postures.

Strength:

Assess gross strength of the patient's trunk and extremities. Consider the potential development of any proximal muscle weaknesses that may have occurred due to bedrest and/or the effects of anti-rejection steroids. Perform a more concentrated muscle test of the patient's hip musculature.

Sensation:

Gross assessment of the integrity of patient's sensory system via light touch & sharp/dull testing is sufficient in most cases. More detailed sensory testing may be indicated if the gross assessment test is abnormal, or if the patient has any history that may warrant further testing (e.g., Diabetes, h/o CVA or any other neurologic problems).

Posture/alignment:

Note the presence of any postural abnormalities that the patient may have developed through the course of their illness. Note any postural abnormalities that may have developed because of abnormal breathing patterns, from prolonged immobility or bed rest, or because of proximal muscle weakness and strength imbalances.

Function:

Ongoing assessment of the patient's ability to perform bed mobility, transfers, ambulation level surfaces, ambulation on stairs. Be aware that proximal muscle weakness, if present, may significantly affect the patient's ability to perform sit to stand transfers and stair training.

Hemodynamic Monitoring:

- All activity is monitored by measuring the patient's heart rate (HR), blood pressure (BP), oxygen saturation (O2 sat), respiratory rate (RR), rate of perceived exertion (RPE),
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and/or rate of perceived dyspnea. Further monitoring may be indicated if the patient is being monitored or supported via any special equipment, such as a PA line or ventilator.

- Baseline values are noted and repeated routinely throughout the patient's activity program as the activity is advanced. Any abnormal results should be highlighted, and the patient's activity may need to be stopped or modified.
- Be aware that the patient's heart rate response to activity will likely be blunted, and an increase in heart rate should not be relied on as a limiting factor of the heart transplant recipient's activity.
- In addition, cardiac denervation often prevents the patient from feeling the symptom of chest pain, as noted above.
- Abnormal responses to activity include: decreasing systolic blood pressure or the failure of the patient's BP to elevate in response to activity, development of arrhythmias, patient reporting excessive fatigue with activity, lightheadedness/faintness or any other subjective complaint such as leg cramping.

Outcome Measures:

- Six- minute walk test (6 MWT): A 6 MWT should be performed in this population of patients, unless contraindicated for any reason, to allow for appropriate endurance exercise prescription. In patients who remain in the hospital, this will also provide information regarding the patient's progress over time.
- Further balance, gait, and strength assessments (i.e.: Berg Balance Scale, Timed Up and Go, gait speed, 30 second sit to stand test) should also be utilized in this patient population based on their baseline functional status and ability.

Assessment:

Problem List

Potential impairments include but are not limited to:

Pain

Decreased muscular strength

Decreased ROM

Impaired posture

Impaired skin integrity

Decreased balance

Decreased aerobic capacity/endurance

Decreased patient knowledge regarding postoperative cardiac transplant precautions and activity/exercise progression

Potential functional limitations include:

Bed mobility

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Transfers

Ambulation level surfaces

Ambulation stairs

Ambulation distances

Prognosis:

The patient should be independent with all their basic functional mobility at home and in the community immediately upon discharge from the hospital, or soon thereafter. Initial functional activities and exercises need to be restricted to within the limits of the patient's sternal precautions.

The patient who has undergone a cardiac transplant should be able to attain a higher level of function and exercise tolerance than they had prior to surgery, although peak cardiorespiratory and cardiovascular responses to exercise in patients with orthotopic heart transplantation are blunted in comparison to normal age-matched norms.² "Suggested reasons for persistently abnormal exercise capacity in the early posttransplant period include 1) marked deconditioning prior to transplant due to heart failure; 2) surgical denervation; 3) corticosteroid therapy; 4) peripheral vasoconstriction."¹⁸

"Skeletal muscle atrophy may have more of a significant effect than cardiac function post heart transplant and this may explain the reason for continued fatigue despite good cardiac function."¹³

Studies demonstrate that exercise training provides positive results in the heart transplant recipient's activity tolerance and muscular strength. Exercise training has been shown to be effective in improving exercise tolerance and aerobic capacity in patients who have undergone a heart transplant. It was shown that over time, patients can increase their average maximum MET level from approximately 5.0 to 6.0 METs with improvement in their physical work capacity on the average of 37% from early to late post-transplantation.² In a study by Kobashigawa et al¹⁶ it was shown that exercise training initiated early after cardiac transplantation improved physical work capacity. It was also demonstrated in a study by Braith et al.⁶ that a 6-month resistance exercise program is successful in preventing the effects of steroid-induced myopathy.

It is now known that the autonomic nervous system gradually becomes reinnervated over time. It was demonstrated that the heart rate response improves significantly during the first 6–12 months post heart transplant, with a further increase thereafter. Further studies showed an average time of reinnervation of approximately 4 years with a mean maximum HR of 94% of predicted.²³ Studies are hopeful that this will allow for higher intensity interval training in this patient population.²² This information is important for the inpatient physical therapist to know for long-term goal planning and patient education.

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Goals:

Goals to be achieved in 1-2 weeks for discharge to home:

- Independent mobilization including bed mobility, transfers, ambulation level surfaces and stairs
- Patients will demonstrate a steady gait with the least restrictive assistive device
- Patients will tolerate specified ambulation distances level surfaces and stairs with stable vital sign responses to activity, utilizing pacing techniques
- Functional range of motion and strength of all extremities within the limitations of their sternal precautions
- Patient will be independent in a home endurance exercise program
- Patient will be independent in a home strengthening exercise program
- Patient will demonstrate a good understanding of the following information: how to safely advance their exercise programs; sternal precautions; home safety; effects of denervation on the heart; methods for counteracting the effects of steroids.

Treatment Planning / Interventions

Established Pathway ___ Yes, see attached. _X_ No

Established Protocol ___ Yes, see attached. _X_ No

Interventions most commonly used for this case type/diagnosis

Pacing and prolonged warm-up and cool-down periods of 5-10 minutes are encouraged with all activity in this population of patients.

Progression of therapeutic exercise program:

- Initial exercises may include supine active or active assisted range of motion (AAROM) exercises if the patient is significantly weak.
- The patient is issued a cardiac therapeutic exercise program, and the patient is advanced from active supine exercises and seated exercises to standing exercises.
- Weights may be added to the program within the limits of their sternal precautions.
- Postural exercises are incorporated into the program.
- Proximal muscle strengthening is important to counteract the effects of steroids and generalized weakness (e.g., partial squats, sit to stand).

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- It has been demonstrated that resistance exercise training can prevent myopathy that is associated with the use of corticosteroids post-transplant⁶, and progression of the patient's weight program should be encouraged once their sternum has healed.

Progression of functional mobility:

- Early intervention often consists of bed mobility via log rolling, transfers, and initial ambulation with the use of assistive devices.
- Use assistive devices initially that allow for the greatest endurance training and wean from assistive devices as appropriate as the patient's balance/gait allows.
- Encourage an ambulation program of at least three times daily with the assistance of nursing staff or family if appropriate and advance towards independent ambulation.
- The distance of ambulation will be determined by the patient's hemodynamic and perceived responses to activity during their therapy sessions.
- The patient is advanced to stairs once they are ambulating functional distances as tolerated. The patient may require a shorter practice step in their room initially if proximal muscle weakness is present.
- Continuous patient education is needed to encourage self-monitoring.

Progression of patient's endurance training program:

- Per American College of Sports Medicine (ACSM) guidelines, the heart transplant patient should perform aerobic exercise 4 to 6 days/week while progressively increasing the duration of training from 15 to 60 min/session.³
- Warm-up and cool-down periods of 5-10 minutes are always incorporated into the patient's training program, as previously stated.
- The endurance program is initially addressed along with the patient's function. A walking program is established as soon as possible postoperatively. The distance encouraged is based on the patient's tolerance to activity during physical therapy sessions and advanced accordingly. A 6 MWT may be performed to further guide prescription of a patient's walking/endurance program.
- Other options for endurance training while the patient is an inpatient at Brigham and Women's Hospital include use of a restorator, stationary bike, or treadmill (located on Shapiro 6W). When starting any endurance training, the patient's HR, BP, RR, SpO₂, RPE, and perceived dyspnea are monitored prior to activity, and in regular intervals during the activity (~every 5 minutes), and in regular intervals following cessation of the activity.
- Regardless of the mode of exercise, the patient's program is progressed in terms of frequency, duration and intensity, as the patient tolerates. Interval training is often used to advance their program.

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- In preparation for discharge home, the patient's home endurance exercise program is established. The therapist should discuss early in the patient's course their available resources for exercise equipment at home. The patient is encouraged to choose types of exercises that they will enjoy. Any exercise equipment that requires use of the upper extremities (e.g., elliptical or row machine) needs to be avoided until their sternum is completely healed. Recommendations are provided in terms of mode, frequency, duration and intensity for each individual patient.
- A 6 MWT test is performed prior to discharge from the hospital. The results of the test should aid the therapist in developing an appropriate home exercise program.
- Per the American Physical Therapy Association's (APTA) guidelines for monitoring of cardiovascular patients, the following are indications for discontinuing or modifying activity:
 - Pallor, peripheral cyanosis; cold, moist skin
 - Staggering gait, ataxia
 - Confusion or blank stare in response to inquiries
 - Resting heart rate > 130 bpm, < 40 bpm
 - More than 6 arrhythmias (irregular heart beats) per hour
 - Uncontrolled diabetes mellitus (BS > 250 mg/dL)
 - Oxygen sat < 85%
 - Acute infection or fever > 100 degrees F
 - Inability to converse during activity
 - Fall in SBP with increased activity (10 mmHg or more)
 - Rise in SBP > 250 mmHg or diastolic pressure > 120 mmHg
 - Patient's request ¹

Frequency & Duration:

Frequency and duration of treatment will vary depending on the patient's needs. The patient immediately post-op heart transplant may only tolerate brief sessions of therapy while they are in the ICU, and the patients should be encouraged to perform regular exercises on their own or with the assist of staff or family if possible. The frequency and duration of treatment will often increase as their tolerance to activity increases. The patient may require 5-7 day/week frequency as they approach discharge from the hospital.

Patient / family education:

Topics of education that are addressed with the patient and family include: 1) Recommendations for the patient's home exercise program including a strength training program and endurance training program, 2) Importance of warm-up and cool-down periods of activity during exercise with a denervated heart, 3) Self-monitoring during exercise including the probability of the absence of chest pain as an indicator of excessive workload, 4) sternal precautions, 5) handling times of rejection in terms of their mobility and exercise, and 6) importance of adherence to a

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strengthening program to counteract the effect of steroids in terms of muscle weakness and bone quality.

Refer to the Cardiac Heart Transplant patient education handout located on the T-drive or via the Smartphrase: .carhearttransplanteducation

Recommendations and referrals to other providers:

- Referral to social work or psychiatry is warranted if the patient is having trouble coping with the issues surrounding heart transplantation.
- Refer the patient to occupational therapy if the patient is demonstrating difficulties with their activities of daily living (ADLs).
- Care coordination may need to be involved if there are any issues regarding the patient's discharge plans.

Re-evaluation / Assessment

The patient will be reassessed every 7-10 days while they are an inpatient as per department guidelines. Other circumstances that warrant reassessment include: a significant change in the patient's medical status, the patient is ready to advance beyond the original goals, or the patient is being discharged from the facility.

Discharge Planning

Commonly expected outcomes at discharge:

Independent mobilization with the least assistive devices and an independent strengthening and endurance program are the optimal goals for discharge.

Transfer of Care

The heart transplant patient is typically discharged to home with an independent home program. Patients who have not reached a level of being able to go home may be discharged to an extended care facility, however a home plan is encouraged if possible due to the higher risk of infection in this patient population. Home VNA physical therapy may be indicated on an individual basis for patients who are safe to go home with or without assistance, but who require further PT intervention to complete their rehab goals. Patients should ultimately be referred to outpatient cardiac rehabilitation, and they are encouraged to seek a referral for cardiac rehab from their cardiologist. A list of Cardiac rehab facilities by state is located on the T-drive.

Patient's discharge instructions

The patient will be discharged to home with an individualized strengthening program to be performed 2-3 days/week, and an individualized endurance program to be performed 4-6 days/week.³ Specific recommendations are provided to each patient in terms of mode,

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frequency, intensity and duration of exercise upon discharge. They are also instructed how to safely advance their home program.

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References

1. American Physical Therapy Association, Acute Care Section. Cardiovascular Monitoring Guidelines.
2. Badenhop D T. The therapeutic role of exercise in patients with orthotopic heart transplant. *Medicine and Science in Sports and Exercise*. 1995; 27(7): 975-985.
3. Balady GJ, Berra KA, Golding LA, Gordon, NF, Mahler, DA, Myers JN et al. ACSM's Guidelines for Exercise Testing and Prescription. 6th ed. Baltimore, MD & Philadelphia, PA: Lippincott Williams & Wilkins; 2000.
4. Benjamin et al American Heart Association- Heart Disease and Stroke Statistics- 2017 Update: Chapter 26. Medical Procedures. *Circulation*. 2017;135:e146–e603.
5. Braith RW. Exercise training in patients with CHF and heart transplant recipients. *Medicine and Science in Sports and Exercise*. October, 1998; 30(10)supplement:S367-372.
6. Braith RW, Welsch MA, Mills RM, Keller JW, Pollock ML. Resistance exercise prevents glucocorticoid-induced myopathy in heart transplant recipients. *Medicine and Science in Sports and Exercise*. April, 1998; 30(4): 483-489.
7. Cahalin LP, Buck LA. Cardiac Transplantation and Acute Care Outcomes. *Acute Care Perspectives of the American Physical Therapy Association*. Fall 2005; 14(3): 1-8.
8. Chou YY, Lai YH, Wang SS, Shun SC. Impact of Fatigue Characteristics on Quality of Life in Patients After Heart Transplantation. *J Cardiovasc Nurs*. 2017.
9. Drakos SG, Uriel N Advances in cardiac transplantation. *Curr Opin Cardiol* 2017, 32:283–285.
10. Eisen, Howard J, Hunt, Sharon A, Yeon, Susan B. Up to Date Website- Heart Transplant Beyond the Basics. <https://www.uptodate.com/contents/heart-transplantation-beyond-the-basics>. Accessed March 2017.
11. Erasmus M, Neyrink A, Sabatino M, Potena L. Heart allograft preservation: an arduous journey from the donor to the recipient. *Curr Opin Cardiol* 2017; 32:292–300.
12. Hasan R, El Ela AA, Goldstein D. Innovations in cardiac transplantation. *Curr Opin Cardiol* 2017; 32:336–342.

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13. Humes HD, DuPont HL, Gardner LB, Griffin JW, Harris ED, Hazzard WR et eds. Medical Management of the Cardiac Transplant Patient. In: Kelley's Textbook of Internal Medicine, 4th ed. Lippincott Williams & Wilkins; 2000. Available at: <http://ovidsp.tx.ovid.com/spb/ovidweb.cgi>. Accessed July 18, 2008.
14. Irion GL, Benefield P, Bolton R, Collins G, Davidson K. Effects of Shoulder Range of Motion on Sternal Skin Stress. *Acute Care Perspectives of the American Physical Therapy Association*. 2005(15)3:13-14.
15. Irion GL, Boyte B, Ingram J et al. Sternal Skin Stress Produced by Functional Upper Extremity Movements. *Acute Care Perspectives of the American Physical Therapy Association*. 2007;16(3):1-5.
16. Kobashigawa JA, Leaf, DA, Lee N, Gleeson MP, Liu H, Hamilton MA et al. A Controlled Trial of Exercise Rehabilitation after Heart Transplantation. *The New England Journal of Medicine*. Jan 28, 1999;340(4):272-277.
17. Kuo J, Butchart EG. Sternal wound dehiscence. *Care of the Critically Ill*. 1995;11(6):244-248.
18. Lyn ET. Emedicine article: Transplants, Heart. Available at: <http://www.emedicine.com/merg/topic786.htm> Accessed September 11, 2008.
19. Mancini MC. Heart Transplantation. Emedicine article. Available at: <http://www.emedicine.com/med/topic3187.htm>. Accessed June 12, 2007.
20. McGregor WE, Trumble DR, Magovern JA. Mechanical Analysis of Midline Sternotomy Wound Closure. *Journal of Thoracic & Cardiovascular Surgery*. 1999;117(6):1144-1150.
21. Nytrøen K, Rustad LA, Aukrust P, et al. High-intensity interval training improves peak oxygen uptake and muscular exercise capacity in heart transplant recipients. *Am J Transplant*. 2012;12(11):3134-42.
22. Nytroen K, Gullestad, L. Exercise after heart transplantation: An overview. *World J Transplant* 2013 December 24; 3(4): 78-90.
23. Nytrøen K, Gullestad L. Exercise after heart transplantation: An overview. *World J Transplant*. 2013;3(4):78-90
24. Olbrecht VA, Barreiro CJ, Bonde PN, et al. Clinical outcomes of noninfectious sternal dehiscence after median sternotomy. *Ann Thorac Surg*. 2006;82(3):902-7.

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25. Organ Procurement and Transplantation Network (OPTN) Policies

https://optn.transplant.hrsa.gov/media/1200/optn_policies.pdf#nameddest=Policy_06

(Accessed June, 2017)

26. Paz JC, West MP. Acute Care Handbook for Physical Therapists. 2nd Edition. Boston: Butterworth-Heinemann. 2002.

27. Pina IL. UpToDate website. Rehabilitation after Cardiac Transplantation. Available at: http://www.utdol.com/utd/content/topic.do?topicKey=hrt_tran/6257&view=text. Accessed August, 2008

28. <https://www.unos.org/> (accessed June 2017)

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