



Standard of Care: Cardiac

Inpatient Physical Therapy Management of the Surgical and Non-Surgical Patient with Cardiac Disease

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BRIGHAM AND WOMEN'S HOSPITAL

Department of Rehabilitation Services

Physical Therapy

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ICD 10 Codes: [Back to top](#)

Highlighted hyperlinks allow users who have access to the internet to link to the World Health Organizations ICD-10 Code Descriptions. All information or links are subject to change without notice in this document.

[I00-I02](#) Acute rheumatic fever

[I05-I09](#) Chronic rheumatic heart diseases

[I10-I15](#) Hypertensive diseases

[I20-I25](#) Ischemic heart diseases

[I26-I28](#) Pulmonary heart disease and diseases of pulmonary circulation

[I30-I52](#) Other forms of heart disease

[I70-I79](#) Diseases of arteries, arterioles and capillaries

[I80-I89](#) Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified

[I95-I99](#) Other and unspecified disorders of the circulatory system

[Q20-Q28](#) Congenital malformations of the circulatory system

[R00-R09](#) Symptoms and signs involving the circulatory and respiratory systems

Case Type / Diagnosis: This standard of care applies to patients with cardiac disease including, but not limited to: cardiomyopathy (CMP), heart failure (HF), coronary artery disease (CAD), myocardial infarction (MI), valvular disease, endocarditis, myocarditis, or pericarditis; and to patients status post (s/p) cardiac surgical procedures including, but not limited to: coronary artery bypass graft (CABG), valve replacement or repair, percutaneous transluminal coronary angioplasty (PTCA), percutaneous coronary intervention (PCI), repair of atrial or ventricular septal defect (ASD, VSD), Cox-Maze procedure, transmyocardial laser revascularization (TMLR), pericardiectomy, aortic aneurysm repair, radiofrequency ablation (RFA), or pulmonary artery embolectomy. This standard of care does not specifically address patients who are s/p ventricular assist device (VAD) or s/p orthotopic cardiac transplant (OHT). For standard associated with Physical Therapy management of these patient populations, please refer to the respective standards of care.

The language used in this standard is consistent with the World Health Organization (WHO) International Classification of Function, Disability, and Health (ICF). The International Classification of Functioning, Disability and Health, also known as ICF, is a classification of health and health-related domains.¹ These domains are classified from body, individual and societal perspectives by means of two lists: a list of body functions and structure, and a list of domains of activity and participation.¹ Since an individual's functioning and disability occurs in a context, the ICF also includes a list of environmental factors.¹ For more information on this type of documentation please refer to your mentor or reference material available in the department or on-line.

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Indications for Treatment² [Back to top](#)

Based on a consensus of 22 expert practitioners from Europe and Canada, below are lists of indications of body changes and activity or participation restrictions based on the ICF Core set for patients with cardiopulmonary conditions in the acute hospital.³

Body Structures

Heart (s4100), Arteries (s4101), Veins (s4102), Capillaries (s4103), Lymphatic vessels (s4200), Trachea (s4300), Lungs (s4301), Thoracic Cage (s4302), Muscles of Respiration (s4303), Skin Of Trunk And Back (s8105), Skin of upper extremity (s8102), Skin Of Lower Extremity (s8104)

Body Functions

Heart Functions (b410), Blood Vessel Functions (b415), Blood Pressure Functions (b420), Respiratory Functions (b440), Respiratory Muscle Functions (b445), Additional Respiratory Functions (b449), Exercise Tolerance (b455), Energy and drive functions (b130), Immunological system functions (b435), Ingestion functions (b510), Urinary excretory functions (b610), Mobility of joint functions (b710), Muscle power functions (b730), Repair functions of the skin (b820)

Activity and Participation

Carrying out daily routine (d230), Managing one's own activity level (d2309), Handling stress and other psychological demands (d240), Speaking (d330), Change basic body position (d410), Maintaining a body position (d415), Transferring oneself (d420), Walking (d450), Caring for body parts (d520), Dressing (d540), Intimate relationships (d770), Work and employment (d845), Community life (d910), Recreation and leisure (d920), Sound (e250), Air quality (e260), Support and relationships: Immediate family (e310), Friends (e315), Individual attitudes of friends (e420)

Contraindications, Precautions, and Considerations for Treatment: [Back to top](#)

New staff should discuss the role of physical therapy (PT) and address additional precautions specific to the patient and situation prior to patient interaction, with a staff mentor, clinical specialist, or PT supervisor.

1. Device

A. Intra-aortic balloon pump (IABP) [Back to top](#)

IABPs are temporary devices to support cardiac pump function and improve blood flow to the myocardium. Patients with IABPs are therefore typically hemodynamically unstable and inappropriate for therapeutic exercise programs. Protection of the catheter's integrity is of utmost importance.⁴ In specific cases, the therapist may receive a consult from the MD for therapeutic exercise to uninvolved extremities. In these instances movement and activity should be limited to avoid disruption of the catheter, balloon rupture, or incision site infection.

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- i. Avoid hip flexion greater than 70 degrees on the side where the catheter is inserted.⁵
- ii. Minimize extreme joint range of motion.⁵

B. Pulmonary Artery (PA) catheter (or Swan-Ganz catheter) [Back to top](#)

The presence of a PA catheter (line) indicates that patient is potentially hemodynamically unstable and/or needs continuous invasive monitoring. Often these patients are on bed rest and inappropriate for PT until stabilized. In instances when the patient is medically appropriate for PT and continues to have a PA line in place, activity orders may be for therapeutic exercise or bed to chair. Prior to initiation of PT, check with the nurse that the PA line has been locked. Locking the PA line prevents the catheter tip from advancing into the PA, which can lead to vessel rupture or stimulation of the SA node causing potentially lethal cardiac arrhythmias. All PA lines inserted at Brigham & Women's Hospital are locked. If you are unsure of the PA line status, clarify with the RN if the PA line was inserted at Brigham & Women's Hospital and if not, if it can be locked. To minimize movement in a locked PA line, ipsilateral shoulder flexion is limited to 90 degrees and only functional use of the contralateral upper extremity (UE) is allowed.

Patients being admitted for management of acute decompensated heart failure or pending orthotopic heart transplant may have PA lines placed for 1-2 weeks at a time for tailored medical therapy. In these instances, a seated exercise program may be considered if the MD clears the patient for this activity. In rare instances a PT supervised stationary bicycle program may be initiated. When developing a plan of care for a patient with a PA line, consider the following:

- (1) Avoid ROM and therapeutic exercise to the ipsilateral shoulder, since movement of the PA line may cause arrhythmias, intravascular injury, or the line may become dislodged.
- (2) Other sites have suggested considering cautious range of motion at the elbow and wrist on the ipsilateral side in addition to the shoulder.⁵

C. Chest Tube (CT) [Back to top](#)

Chest tubes are inserted to maintain pulmonary inflation and/or to drain fluids from the thoracic or mediastinal cavities. Maintaining the integrity of this closed system by keeping the chest tube upright and the water seal trap in place prevents lung collapse and ensuing respiratory distress. Use of low wall suction may be employed to maintain a closed system when there is a large air leak from the lung to the thoracic cavity. When the air leak is small or when the necessity of continued chest tube use is being evaluated, the CT may not require suction but remain on water seal or have temporary surgical clamps in place on the tubing. Prior to PT examination or treatment, consider the following: Clarify if chest tube needs to remain to suction prior to physical therapy intervention. If continuous suction is necessary either use portable suction unit if walking in hall, or extended tubing to allow increased patient activity in room.

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Chest PT and shoulder ROM exercises to patient's tolerance are beneficial in the management of pulmonary ventilation and airway clearance.⁵ Removal of a CT may result in the development of a pneumothorax or exacerbation of the initial air leak related to lung tissue injury. PT examination or treatment sessions are usually deferred after CT removal until a follow-up chest x-ray (CXR) is performed and read by a physician assistant (PA) or physician (MD) to rule out a pneumothorax. In rare instances, the timing of a CXR or reading of the film may be delayed. If waiting for the CXR is limiting a beneficial treatment session, a discussion with the PA or MD and your PT mentor is indicated. If the decision is made to treat the patient, monitor for signs of acute pneumothorax (acute shortness of breath, new or increased palpable crepitus felt anywhere in the thorax, precipitous drop in SPO₂ from baseline or < 80%).

D. Permanent Pacemaker (PPM) and/or Implantable Cardioverter-Defibrillator (ICD)

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The insertion of a PPM or ICD may occur to maintain appropriate cardiac conduction or prevent cardiac arrhythmias. The device is usually inserted under the skin in the left infraclavicular pocket, with leads inserted into the right side of the heart via the left subclavian vein to the superior vena cava. In instances where insertion via a left subclavian pocket is not possible or after an infection of a left pocket, the new device may be inserted via the same routes on the right side. Device leads are either attached via passive (tined) or active (screw) fixation into the myocardium.⁶ Precautions in movement during this time are focused on incision and lead healing and fixation respectively. Although current literature has not investigated the time frame for the leads to firmly attach into the myocardium, current recommendations from physicians indicate that 4-6 weeks allows incision healing and firm adhesion of pacemaker leads.⁶ Current precautions reflecting physician preference include:

- i. Keeping the involved UE in a standard sling for 24 hours.
- ii. No therapeutic exercise to involved shoulder for 4-6 weeks unless approved by the Electrophysiology Service (EPS).
- iii. Involved UE may be used functionally but limit shoulder flexion and abduction to 90 degrees for 4-6 weeks, then may use functionally as tolerated.
- iv. Patient may use minimal weight bearing (10-15 lbs.) into UE while using an ambulatory assistive device, however use of axillary crutches are not recommended due to venous pressure in the axilla region and incisional stress. In rare instances, use of axillary crutches to safely negotiate stairs may be indicated.
- v. No lifting greater than 5 lbs. with involved UE for 4-6 weeks.
- vi. No driving until after follow up visit with EPS.⁷ At that time, the patient can check with the physician as to when the patient can resume driving.

E. Semi-Permanent Pacemaker [Back to top](#)

Semi-permanent pacemakers are generally used as a bridge therapy when a patient is not clinically able to tolerate a permanent pacemaker placement (e.g. infection with positive blood cultures). The device wires are placed transcutaneously with the pacemaker external and secured with subcutaneous sutures and a dressing. Given the location and

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lack of permanent fixation, mobility of the ipsilateral shoulder is generally contraindicated. Seek clarification of activity orders out of bed with MD and EPS.

F. Temporary Pacemaker (External Pacemaker) [Back to top](#)

Temporary pacemakers are often left in place after cardiac surgery when the risk of cardiac arrhythmias is most great.⁸ Patients may be dependent on this pacemaker for cardiac rhythm, or the device may be in place to take over in the event of an adverse cardiac rhythm (usually bradycardia) and just sensing (a.k.a. “back-up mode”). The wires are either stitched internally or placed against the myocardium, therefore restriction of movements of the UE are necessary to maintain wire integrity. There are 2 types of temporary pacing wires:

- i. Epicardial pacing wires placed during cardiac surgery. No UE ROM restrictions as the wires are transthoracic.
- ii. Transvenous pacing wires. No ROM assessment or therapeutic exercise to the involved shoulder as the wires are placed through the internal jugular or subclavian line.

Mobilization of a patient with temporary pacing wires is considered appropriate however, caution should be taken to avoid dislodging the wires by having the RN reinforce the dressing over the wires, if needed, and by carrying the temporary pacing box in a safe location close to the patient.

When no longer needed the pacing wires may also be detached from the temporary pacing device, capped with insulating wire caps, and taped to patient’s chest. Inspection of wire positioning prior to activity and reinforcing of the dressing by the RN may be indicated. When epicardial pacing wires are removed, they are either cut at the skin level or pulled through the skin. When removed through the skin, there is a risk of bleeding where they were attached to the myocardium and therefore these patients are monitored for signs of cardiac tamponade (i.e., tachycardia, lightheadedness, dyspnea) and follow this progression of activity to allow for monitoring:

- i. Patient may be out of bed with RN in room after 1 hour of bed rest.
- ii. Patient may participate with PT after 2 hours.
- iii. Patient may initiate or resume stair training after 4 hours.

2. Procedure-Related (Non-Device)

A. Sternal Precautions [Back to top](#)

Consideration should be taken to identify those patients who have multiple risk factors for sternal wound dehiscence and these patients should be encouraged to strictly adhere to the following sternal precautions. Surgeons may also identify patients at high risk for sternal wound dehiscence in the operating room and either use a modified closure (Robicsek weave) or write orders for strict sternal precautions during the post operative course. Patients who may be at high risk for sternal dehiscence include:^{9,10}

- i. Use of internal mammary artery (IMA) in the bypass graft

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- ii. Females with pendulous breasts
- iii. Morbid obesity
- iv. Barrel chest
- v. History of poorly controlled diabetes mellitus
- vi. Osteoporosis
- vii. Redo operation for bleeding or repeat cardiothoracic surgery

Current recommendations for sternal precautions are considered best practice. Current literature does not support all the imposed restrictions, and clinical judgment to allow safe and functional return should be considered and discussed with the medical team and the patient. Patient's s/p full sternotomy without signs of sternal infection should follow sternal precautions for 12 weeks to avoid undue stress to the healing sternum. Patients with minimally invasive (partial) sternotomies should follow sternal precautions until surgeon clearance. Current sternal precautions include:

- i. Avoid simultaneous bilateral shoulder flexion, abduction greater than 90 degrees.
- ii. Encourage unilateral UE active ROM as tolerated to facilitate functional mobility gains and reduce the risk of shoulder ROM impairments and muscle performance changes.¹¹⁻¹⁵
- iii. Log rolling for bed mobility to avoid strong contraction of the abdominal muscles pulling on their superior sternal/costal attachment. Consider trunk stabilization activities.¹⁶
- iv. Avoid activities that may cause excessive Valsalva maneuver.¹⁷
- v. Encourage chest splinting with pillow when coughing.
- vi. UE strength/ROM testing for strength grades greater than 3/5 should be performed only if neurological changes are suspected to have occurred.
- vii. Avoid full weight bearing through upper extremities (e.g., gait training must be at least partial weight bearing for ambulation)
- viii. Avoid lifting, pushing, and pulling greater than 10 lbs. for 3 months (no use of bed ladder or trapeze).
- ix. No driving and no sitting in passenger seat behind an airbag for 4 weeks.

B. Reconstructive Flaps For Sternal Wound Closure [Back to top](#)

Patients who have an unstable sternum may require additional measures to close their sternotomy wound. Signs of an unstable sternum are: new sternal pain, incisional drainage, sternal click with breathing or pressure, wound infection, and/or wound/bone necrosis. Reconstruction often takes place using local muscle flaps with the goals of providing tissue coverage and improved blood supply.¹⁸ Soft tissue flaps may include: latissimus dorsi, rectus abdominus, pectoralis major, and greater omentum.^{18,19} There is no current literature citing precautions and time frames for this procedure, however two articles suggest avoiding movements that cause bi-directional sternal stresses including bilateral shoulder extension and shoulder abduction.^{14,17} Surgeon recommendations and conversation with the medical/surgical team and/or mentor therapist is indicated.

C. Harvest site s/p Coronary Artery Bypass Graft (CABG) [Back to top](#)

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Incisions at the harvest site often present as impaired integument and contribute to incisional pain, infection, and edema. Common vessels used for grafting include those harvested from the LE (greater saphenous vein [SVG]) or UE (radial artery). Protection of these incision sites to allow healing of the skin and to decrease pain is indicated. Weight bearing as tolerated for those patients with LE or UE harvest sites considered appropriate. In addition, there are no ROM restrictions given normal healing.

Considerations for PT include:

- i. Providing thigh-high compression garments to those with LE harvest sites
- ii. Elevation of the involved extremity while seated and in bed
- iii. Active ROM to promote edema reduction
- iv. Monitor for signs of infection which include increased rubor, purulent discharge and acute pain. Notify medical team of any new changes.

D. Rule out (R/O) Myocardial Infarction (MI) protocol [Back to top](#)

Patients admitted with acute coronary syndrome (ACS), chest pain, or suspected MI are not appropriate for PT until they have either been ruled out for a MI event, or until they are medically/surgically managed. During a R/O for a MI three sets (one every 8 hours) of cardiac enzymes (creatinine kinase [CK-MB isoform], troponin [Tn-I]), and electrocardiograms (ECGs) are drawn.

If the patient rules in for a MI, new activity orders must be obtained from the MD prior to proceeding with the PT examination or intervention. In general, it can be expected that the patient may resume progressive monitored activity once cardiac biomarkers have peaked and decreased for two sets and once the patient is hemodynamically stable at rest.

In some instances cardiac enzymes may be elevated e.g., cardiac stress related to volume overload (heart failure) or tachy-arrhythmias, or rise from previously lower values e.g., after a cardiac catheterization, and may not indicate a new MI event. Clarify with the physician appropriate activity orders.

E. Cardiac Catheterization [Back to top](#)

A catheter is inserted into the left or right side of the heart for diagnostic and interventional purposes. Determine whether only a cardiac catheterization was performed or if additional procedures were performed as well e.g., percutaneous transluminal coronary angioplasty (PTCA) or insertion of coronary artery stents, prior to PT examination or intervention. Activity precautions are aimed at protection of the incision site and are as follows:

Left heart catheterization is used to diagnose left ventricular, atrial, pulmonary vein, and coronary artery impairments. Due to the arterial incision site via the femoral artery, these patients are on bed rest for 6-8 hours with involved LE straight. Patient may have a knee immobilizer donned to minimize hip flexion. The patient is monitored for groin hematomas, and pain. Use of the radial artery is also common and bed rest for 6-8 hours with RUE in splinted extension at the wrist and elbow is maintained. Complications

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associated with a left heart catheterization include groin hematoma and retroperitoneal or intramuscular bleeding in the LE or intramuscular bleeding in the forearm. Also consider a patient's response to the general anesthesia while examining functional mobility.

Right heart catheterization is used to diagnose right ventricular, atrial, and pulmonary artery impairments. The incision site is generally via the external jugular vein and there are no activity restrictions.

F. Electrical Cardioversion [Direct-Current Cardioversion (DCCV)] or Pharmacological Cardioversion [Back to top](#)

Resumption of normal cardiac conduction can improve cardiac output. Medical interventions, either by cardiac electrical shock (DCCV) or with medication (e.g. Ibutilide) are aimed at restoring normal sinus rhythm. Due to potential return of arrhythmias, or patient fatigue associated with anesthesia for DCCV, PT is generally held for 24 hours or until the patient can tolerate activity. Make sure to check for changes to activity orders and monitor for resumption or progression of cardiac arrhythmia.

3. Arrhythmias [Back to top](#)

Cardiac arrhythmias represent an abnormal cardiac conduction that can lead to decreased cardiac output at rest or with activity. A consideration as to how long this arrhythmia has been present (acuity), current or potential medical management, and patient symptoms all should be considerations prior to decisions to treat or defer PT interventions. New or progressive arrhythmias during therapy should be noted and this information relayed to the medical team. The following are additional clinical considerations for specific arrhythmias to aid in deciding whether or not the patient is appropriate for physical therapy.

A. Atrial Fibrillation (AF): AF is a totally disorganized depolarization of the atria resulting in an irregular irregular heart rate and lack of effective atrial contraction.²⁰ Identify heart rate via telemetry. Identify pulse rate by manual or auscultation inspection for one minute. Determine if the patient's current heart rate is elevated or depressed from baseline, the patient's BP is stable and at baseline, and/or if the patient is symptomatic. Indications of uncontrolled AF are a very high rate or wide fluctuations in rate with activity [Back to top](#)

B. Heart Block (HB): Watch for progression of heart block or alteration in rhythm in response to activity.

- i. First degree heart block: Prolonged PR interval. Generally there are no precautions if the patient's HR and BP are stable.
- ii. Second degree heart block:
 - (1) Type I (Mobitz I): PR interval increases until a ventricular complex is dropped. This arrhythmia is frequently noticed with increasing activity.
 - (2) Type 2 (Mobitz II): PR interval is increased. Type 2 is noted by the number of atrial contractions needed to propagate a ventricular contraction (e.g. 2:1). This

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arrhythmia can follow a Mobitz I or be seen as a progression in a person with first degree HB.

- iii. Third degree (Complete heart block): There is a complete lack of synchrony between atrial and ventricles observed on the EKG, resulting in a greatly reduced ejection fraction and potential for hemodynamic instability. PT is deferred until the patient has a PPM. If the patient progresses to this rhythm during treatment they may become lightheaded or syncopal, this is a medical emergency and the patient needs immediate medical attention. [Back to top](#)

C. Premature Ventricular Contraction (PVC): A PVC is a ventricular contraction initiated by a foci within the ventricle, not stimulated via the sinoatrial node through the normal cardiac conduction pathway. PVCs are commonly found in the aging patient population and with higher incidence in patients with cardiac health conditions or after cardiac surgery.²⁰ PVCs can be palpated or observed via ECG. While generally benign, considerations of acuity, frequency, hemodynamic response, and patient subjective response should be investigated. [Back to top](#)

D. Ventricular Tachycardia (VT): VT is defined as three or more consecutive premature ventricular contractions.²⁰ VT can be palpated or observed via ECG. Patients may also report a fluttering sensation in their chest or complain of feeling lightheaded or dizzy. Sustained VT is a very serious arrhythmia that can result in greatly decreased cardiac output due to ventricular contraction without time for refilling with adequate blood. Runs of VT are frequently seen in patients with heart failure and may be considered baseline for certain patients. Consideration of acuity, frequency, duration of the VT, patient symptomatology (i.e., lightheadedness, dizziness and/or confusion), and current pharmacological interventions are mediating factors in a clinical decision. New onset of VT, long runs of VT and patient symptoms may indicate that the patient is not likely to be clinically appropriate for PT. [Back to top](#)

E. Ventricular Fibrillation (VF): VF is defined as absence of organized ventricular activity and presents as irregular undulations of varying contour and amplitude on ECG.²⁰ There is no cardiac output and the patient will usually die within 3-5 minutes if a more normal cardiac function is not restored.²⁰ This is a medical emergency and the patient needs immediate medical attention. [Back to top](#)

4. Medications [Back to top](#)

Consider timing of PT intervention with patient's medication schedule. A medication's time to peak concentration can be found in MicroMedex. The administration of certain medications generally indicates that the patient is hemodynamically unstable and/or has complex medical issues. Discussion regarding the goals of PT intervention on a case-by-case basis should occur prior to PT treatment session with staff mentor, clinical specialist, or PT supervisor and a member of the physician team. Clarify with the MD an appropriate activity level for patients on vasoactive medications: vasodilator, inotropic/vasopressor, antiarrhythmic, and antianginal. The following medications are commonly prescribed for the

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cardiac patient. Specific information about the following medications can be found in Appendix II or via the hyperlink.

- a. Pulmonary Vasodilators
 - [Nitric Oxide \(NO\)](#)
 - [Epoprostenol \(Flolan or Prostacyclin\)](#)
- b. Peripheral Vasodilators
 - [Sodium Nitroprusside \[SNP\] \(Nipride\)](#)
- c. Vasopressors or Inotropic
 - [Dopamine](#)
 - [Dobutamine](#)
 - [Milrinone \(Primacor\)](#)
 - [Midodrine](#)
 - [Inamrinone \(Inocor\)](#)
 - [Norepinephrine \(Levophed\)](#)
 - [Phenylephrine \(Neosynephrine\)](#)
 - [Epinephrine](#)
 - [Vasopressin](#)
- d. Anti-Arrhythmics
 - [Amiodarone](#)
 - [Lidocaine](#)
- e. Anticoagulants or Thrombolytics
 - [Bivalirudin \(Angiomax\)](#)
 - [Heparin](#)
 - [Coumadin \(Warfarin\)](#)
 - [Enoxaparin \(Lovenox\)](#)
 - [Streptokinase](#)
- f. Anti-Anginals
 - [Nesiritide \(Natreacor\)](#)
 - [IV Nitroglycerin \(NTG\)](#)

Examination [Back to top](#)

1. Current Patient Condition and Hospital Course
 - A. HPI & PMH
 - i. Onset and duration of symptoms and reason for admission.
 - ii. Anthropometrics: (height, weight, BMI): Use estimated dry weight or recorded weight on day of evaluation. Clarification statement of increased water weight should, when indicated, be included.
 - iii. Reason for PT consult.
 - B. Hospital Course
 - i. Previous and ongoing medical and/or surgical treatment, date of any procedures and any post-operative complications.
 - ii. Current laboratory results: WBC=, HCT=, HGB=, PLT=, INR=, PTT=, Blood Sugar=, ABG (written in format: pH/ PCO₂/ PO₂/ HCO₃ (or Base Excess)/ SO₂).

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- iii. Diagnostic tests: echocardiogram, cardiac catheterization, exercise tolerance test, pharmacological stress test, and electrophysiological studies.
 - C. Social History
 - D. Prior functional and endurance level (e.g., Patient could walk for 1 block without rest).
 - E. Home environment and current/potential barriers to returning home.
 - F. Family/caregiver support system available.
 - G. Family, professional, social and community roles.
 - H. Patient's goals and expectations of returning to previous life roles.
 - I. Prior drug use, tobacco use (pack-year history), alcohol use (drinks/day).
 - J. Pertinent Current Medications
2. Determine Medical Stability: Prior to a physical examination or intervention, determine medical stability by reviewing both the paper chart, and online chart, along with a discussion with the physician, physician assistant (PA), nurse practitioner (NP), or nurse (RN) covering the patient. Consider the following when determining medical stability. [Back to top](#)
- A. Stable ECG pattern > 24 hours and without significant arrhythmia at rest.
 - B. Stable vital signs at rest.
 - C. Controlled or stable anginal pattern.
 - D. CHF controlled, no dyspnea at rest.
 - E. Significant changes in patient lab profile (complete blood count (CBC), Metabolic Profile (especially electrolytes, kidney function [BUN & Creatinine])).
 - F. Presence of highly vasoactive [medications](#)
 - G. Postoperative condition (e.g. open chest) or complications (e.g. continued or excessive bleeding).
 - H. Blood sugar control.²¹ Discontinue session and take appropriate action with signs of acute hyper- or hypoglycemia. Presence of other symptoms and their management over the past 24 hours:
 - i. Faintness or lightheadedness
 - ii. Nausea
 - iii. Fever
 - I. Vital Signs: Vital signs are an objective measurement of a patient's response to PT. Vital signs should be monitored and recorded prior to, during, and after each PT session during which a change is likely to occur (e.g. functional mobility, chest PT). Physician orders may dictate parameters for heart rate, saturation of peripheral oxygen, or blood pressure. A clinician should consider the trend of vital signs since admission as well as current medications and their effects on vital sign response prior to and with activity. The following are Brigham & Women's Hospital Rehabilitation Services Department's guidelines for vital sign monitoring. If any of the following responses occur during treatment, reassess the patient and determine whether to modify or discontinue the intervention: [Back to top](#)
 - i. Heart Rate (HR): ECG, palpation, or auscultation can all be used to examine HR. Heart rate and pulse rate may be different. HR is the number of ventricular contractions seen on ECG or heard via auscultation. Pulse rate is the number of

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- palpable heart beats in a peripheral artery. Pulse rate and heart rate should be considered separately in patients with irregular heart rhythms to appreciate actual cardiac output. Pulse rate in these patients should be measured for 1 minute via palpation or via 1 minute of ECG strip.
- (1) Considerations for Physical Therapy: Monitor your patient for significant tachy- or bradycardia that is new or changed from baseline as this may indicate an abnormal response to the activity being performed or identify a person not ready to participate in activity with PT.
 - (a) Use of HR for exercise prescription in patients with cardiac health conditions is usually not effective given the effects of cardiac medications on heart rate frequently seen in this patient population. In patients not on beta blockers, several formulas can be used to estimate workload of an activity and to prescribe or recommend exercise at safe levels. The commonly used predicted maximum HR, $(220 - \text{age})$, does not take into consideration a person's resting HR and may result in overtraining. The Karvonen Equation takes into account a person's resting heart rate: $\text{Target HR} = \text{rest HR} + 0.6(\text{max HR} - \text{rest HR})^{22}$, but may overestimate maximum achievable heart rate. Peak HR as achieved by a pharmacological or exercise stress test is the best source of peak HR determination and exercise prescription.
 - (b) Literature suggests that the use of beta-blockers blunts heart rate response and the use of HR alone for exercise prescription may result in under training.²² The increased degree of HR variability or the ability for the heart rate to respond to changing activity is considered a good prognostic factor after cardiac event.²³ A decrease in heart rate (>5 beats/min) with increased activity *or* abnormal HR increase for the level of work being done is considered a poor prognostic indicator.
 - ii. Blood Pressure (BP): Monitoring BP allows the clinician to screen for changes in BP from baseline or in response to activity. Clinical considerations while monitoring BP are as follows and are considered abnormal responses to activity:
 - (1) Narrowing of pulse pressure (falling SBP and rising diastolic BP) is evidence of acute heart failure as the ability of the heart to effectively move blood forward fails.
 - (2) Significant elevation of SBP with minimal activity indicates cardiac deconditioning, e.g. increase in SBP > 20 mmHg *or* abnormal increase for level of work being done *or* decrease from resting SBP,²¹ decrease in DBP > 10 mmHg *or* increase > 20 mmHg.²¹
 - iii. Saturation of Peripheral Oxygen (SpO₂): SpO₂ indicates the percent of oxygen saturation of the red blood cells. This value can give the clinician information on a patient's pulmonary gas exchange ability and insight into their anticipated readiness to participate in an activity. The normal response to activity is to have no change in SpO₂ due to a shift in the oxyhemoglobin curve; however, significant pulmonary impairments may cause this value to change.

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Clinicians should monitor for a significant drop in SpO₂ in relation to activity being performed. Comorbid conditions (e.g., congenital heart defects, COPD), baseline/pre-admission values, and prior supplemental oxygen use should also be taken into consideration to determine the course of action during a treatment session. MD orders generally will give orders for specific SpO₂ values to allow titration of supplemental oxygen. In the absence of MD titration orders, supplemental oxygen should be considered when a patient is unable to maintain SpO₂ >88% or symptomatically hypoxic. If a patient has a significant decline in SpO₂ without recovery within 30 seconds of rest consider using an alternate hand/foot, digit or thumb, ear lobe, or nose to check the accuracy of reading. If the patient does not recover with rest, consider application or up-titration of supplemental oxygen by 1-2L/minute in conjunction with rest and nasal inhalation.

- iv. Respiratory Rate (RR): RR, when used in conjunction with examination of breathing pattern, can give a clinician information on a patient's pulmonary ventilation ability. Most effectively measured without patient knowledge, RR can be measured during HR palpation, indirect observation, or estimated via non-invasive telemetry in the ICU setting. Normal response to activity is an increased depth of breathing prior to an increased rate, however, in patients unable to increase depth, increased RR may be observed first.

Clinical considerations should be taken with significant brady- or tachypnea at rest. In addition tachypnea greater than expected in relation to the activity being performed should also be considered. Significant tachypnea in the acute care setting may be characterized by inability to converse during activity.²¹ Development of a paradoxical breathing pattern with activity may also indicate an impaired pulmonary ventilation response. Patient's subjective complaints (at rest or with activity) [Back to top](#)

- (a) Dyspnea
- (b) Lightheadedness
- (c) Palpitations
- (d) Nausea
- (e) Profound weakness
- (f) Pain

- 3. Physical Examination (Physical / Cognitive / applicable tests and measures / other): Systems Review. This section is intended to capture the most commonly used assessment tools for this case type/diagnosis. It is not intended to be either inclusive or exclusive of assessment tools. Refer to the Outcomes Measures folder in the Rehab folder on the BWH T-drive for test administration and recording information. The physical examination should include a review of systems as follows. [Back to top](#)
 - A. Subjective: Either a patient statement or quality of life outcome measure tool such as Kansas City Cardiomyopathy Questionnaire²⁴ used to quantify degree of physical limitations associated with heart failure; or Minnesota Living With Heart Failure

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Questionnaire, where a total score of 50 or greater may indicate a greater potential for successful rehabilitation.²⁵

B. Observation

- i. Lines, intravenous lines, catheters, chest tubes (to suction vs. H2O seal; mediastinal vs. pleural), arterial lines, method of oxygen delivery if being used, vital sign monitoring equipment.
- ii. Patient presentation: Position, appearance (e.g. disheveled).

C. Cognition/Mental Status

- i. Level of alertness, ability to follow motor commands, and level of safety awareness.
 - (a) Bypass times of greater than 150 minutes is associated with post-pump syndrome and increased neurological insults.²⁶
 - (b) Advanced heart failure and inotropic medical support may have a negative impact on cognition, specifically memory, motor response time, and speed of processing.²⁷
- ii. Consider screening with Mini Mental State Examination, CLOX Testing, or consultation of Occupational Therapy.
- iii. Personality changes, e.g., emotional lability or euphoria related to anesthesia, medication, or surgical intervention.

D. Learning Style and Learning Barriers

E. Pain: Location and severity before, during and after physical therapy intervention with use of a visual analog scale (VAS) 0-10,²⁸ including documentation of how you responded to the reported pain (e.g., informed nurse).

F. Neuromuscular

G. Integumentary: Including surgical incision, edema (0-4+ or girth of limb), and presence of ulcers

H. Head/trunk control or Posture

I. Balance: Use of a functional balance assessment e.g. Tinetti Balance Test, Berg Balance Test, Dynamic Gait Index, Timed Up and Go are to be used when possible. Gross sitting and standing statements are to be used only if unable to perform standardized test.

J. Musculoskeletal

- i. ROM
- ii. Muscle Performance

Endurance: Use of standardized endurance testing is encouraged for all patients.²⁹⁻

³⁶ All patients on the Heart Failure service will complete the 6-Minute Walk Test prior to discharge as appropriate when the patient is medically stable.²⁹ We are currently using separate equations developed by Enright et. al.³⁰ ($7.57 \times \text{height in cm} - 5.02 \times \text{age in years} - 1.76 \times \text{weight in kg} - 309$) for male and female patients 40-80 years old and an equation by Gibbons et. al.³¹ ($868.8 - (2.99 \times \text{age in years}) - (74.7 \times \text{gender})$) for all patients 22-40. Documentation of the distance walked in feet and meters, percent (%) predicted, ability of the patient to complete the test, adverse events, and vital signs including rate of perceived exertion (RPE).

Additional information on average gait speed, average METS can also be calculated and may help with the development of goals or description of patient activity or participation restrictions. An increase of greater than 80 meters

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between testing periods is considered a minimally detectable change,³⁶ and although there is controversy, it has been suggested that persons who ambulate a distance of less than 300 meters have significantly increased mortality and morbidity regardless of sex.³⁷⁻³⁹ A predicted peak VO₂ equation developed by Cahalin et. al.³⁹ can also be calculated ($0.03 \times \text{distance (meters)} + 3.98$ (r² value = 0.42)), but is valid in patients with heart failure only,³⁹ and has not been validated for patients without heart failure.

Strength: A muscle strength that is greater than a 3/5 grade with manual muscle testing is often difficult to quantify due to lack of objective data. The use of the Sit to Stand Test^{40,41} should be considered to quantify functional strength and provide an objective measure to evaluate outcomes related to interventions provided.

K. Pulmonary: Auscultation, breathing pattern, cough quality, management of secretions, and description of sputum if any, e.g. odor, quantity, color.

Evaluation / Assessment: [Back to top](#)

1. Identify a physical therapy diagnosis, if different from medical diagnosis, and rationale.⁴² Identify the need for skilled physical therapy services, e.g. maximize patient functional safety and/or independence in home setting.
2. Health Condition: Referred to as the pathology in the Nagi Model of Disability, this is usually the admission diagnosis.
3. Changes to Body Structure or Function: Referred to as impairments in the Nagi Model of Disability, impairments occur in identified body structure(s) or function(s). Identification of acute or chronic impairments to body structures or functions and their impact on the patient's ability to negotiate her/his environment or participate in activity or role within society should be noted.

Potential body structure changes may include, but are not limited to: median sternotomy and integumentary incisions, and cardiac conduction system. Potential body function or system changes may include, but are not limited to: cardiovascular and pulmonary system deconditioning, aerobic capacity/activity tolerance, muscle performance, balance, and knowledge related to incisional precautions.

Activity restrictions, referred to as functional limitations in the Nagi Model of Disability, in the acute setting may include, but are not limited to: ADLs, ambulation, transfers, bed mobility, and stair negotiation. Descriptors of patient ability to complete an activity (capacity) and ability to perform the activity in an appropriate setting (performance ability) may also help describe your patient and support PT recommendations (i.e. A capacity to complete a task does not mean that their ability to perform that task in their discharge environment is safe or compatible.)

Participation restrictions, referred to as a disability in the Nagi Model of Disability, are influenced by contextual factors. Only when the contextual factors do not allow a person to participate should a person be considered disabled. Examples of participation restrictions in this population may include, but are not limited to: ability to live

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- standing positions first with and then without external support. Consideration should be taken with exercise position and positional effects on blood return to the heart (e.g. increased venous return in supine is likely to be less tolerable to patients with heart failure). In those patients who present with a primary pulmonary impairment to their activity tolerance or in those patients with a mixed cardiopulmonary impairment consideration of respiratory muscle examination and training can also benefit activity tolerance and decrease shortness of breath. Building strength requires a person to perform exercises at greater than 50% of their one repetition maximum. Once a person is able to perform functional activity in the acute setting, strength goals should include resistive exercises, as appropriate, e.g. body weight, functional activities, bands/weight, to facilitate continued strength gains.
- ii. Endurance training can occur with any activity that causes a person to elevate their heart rate or blood pressure from baseline for 20-30minutes, at levels 20-30% of maximal effort. For patients who cannot tolerate this duration of activity, interval training with a lesser duration but increased frequency and/or increased intensity can also produce aerobic changes. An example of initial endurance training for those patients who are severely deconditioned, such as those patients in the ICU, may include increased frequency of transfers to chair, duration of time spent sitting in chair, or time spent sitting unsupported at the edge of the bed. Completion of a seated AROM program, when performed for high repetitions and more than once per day, can also produce endurance changes in patients with limited mobility. Updating the plan of care, posting an activity schedule for other healthcare providers, family, and patient to see can also help with patient compliance with activity schedules.
- B. Functional Mobility Training: Common mobility progression from bed mobility, to transfers, to ambulation, and stair negotiation can be considered. For those who are too deconditioned or require significant amount of assistance to perform repetitions of an assisted functional activity, use of a static or dynamic tilt table (Moveo™) may be indicated to increase standing tolerance, LE strengthening, and hemodynamic response to upright activities.
 - C. Balance Training: Results of a standardized balance test can help guide a clinician in choosing appropriate activities for balance reeducation.
 - D. Gait Training: Assistive device prescription should take into consideration weight bearing status/restrictions and sternal or pacemaker precautions. Use of rolling walkers for those with impairment in their aerobic tolerance should also be considered due to use ability to use accessory muscles of breathing and ability to support the upper body/UE limb while walking.
 - E. Patient/Family Education: It is the role of a physical therapist to discuss realistic expectations regarding function, appropriate level of assist that the patient requires from family, and anticipated rehabilitation progression. Often this entails providing emotional support to the patient and family as needed. Education of conceptual ideas, e.g. energy conservation; self monitoring, e.g. RPE; exercise/activity related interventions, e.g. pursed lips breathing; and/or applicable precautions, e.g., sternal or PPM/ICD precautions are also considered educational points. The department has the following handouts available for those with visual learning styles:
 - i. Home Exercise Programs
 - ii. Energy Savers

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- iii. Exercise Guidelines after Cardiac Surgery, which includes sternal precautions, logrolling technique, and exercise guidelines and prescription.
 - iv. PPM/ICD Precautions
 - v. Aortic aneurysm precautions
- F. Frequency of Treatment: Patients will have follow-up physical therapy treatments based on individual need. The frequency of treatment for each patient will be determined by the potential for gains with skilled therapy and the ability of the patient to complete an activity/exercise prescription independently or with the assistance of other healthcare staff members. Please also refer to the BWH Guidelines for Frequency of Physical Therapy Patient Care in the Acute Care Hospital Setting.
- G. Recommended Referrals to Other Providers
- Based on the PT evaluation and discussion with the patient, patient's family, or patient's healthcare providers, there may be a need for additional services. A patient may benefit from the following services:
- i. Occupational Therapy: If a patient presents with impairments that affect his or her cognition or ability to independently perform activities of daily living and/or has adaptive equipment needs.
 - ii. Speech and Swallowing: If a patient presents with impairments that affect his or her ability to swallow without difficulty and/or presents with a new communication impairment.
 - iii. Care Coordination: If a patient has a complicated discharge situation and the care coordinator is not already involved.
 - iv. Social Work: If a patient has a complicated social history and/or he or she requires additional support or counseling.
 - v. Chaplaincy: If a patient requires spiritual support or counseling.

3. Re-evaluation / Assessment:

Reevaluation will occur under the following circumstances: current short term physical therapy goals have been met however the patient still has skilled PT needs, significant change in medical status occurs, and/or within 10 days from the previous evaluation.

4. Discharge Planning:

A. Commonly Expected Outcomes

Discharge planning will occur on an individual basis depending on the patient's medical, physical and social needs. Discharge planning is a coordinated effort that occurs with the physician, care coordinator, therapist(s), nurse, and the patient and his or her family. Duration of length of stay fluctuates by surgeon/physician, service, and individual patient needs. For example the average length of stay on the cardiac surgical service is 11 days, but data is skewed by patients s/p VAD.

If further physical therapy treatment is warranted, recommendations will be provided to the patient, family, and physician team for appropriate additional rehabilitation services once discharged from the acute care setting. For example, if the patient has significant impairments and functional limitations and/or complicated medical needs at the time of discharge from the acute care hospital, he or she may be discharged to

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an acute or sub-acute rehabilitation facility, skilled nursing facility, or other extended care facility. Home PT may be recommended for patients who require a home safety evaluation or who have not met their short-term goals to be independent at home to address ongoing body impairments or activity/participation restrictions. Outpatient PT may be recommended for patients who have continued body impairments or activity/participation restrictions and who are able to leave their house. Outpatient Cardiac Rehabilitation for those patients who have ongoing aerobic or activity tolerance limitations that have either not significantly improved with an independent Phase I cardiac rehabilitation program or as a progression after completion of the Phase I cardiac rehabilitation program. The patient's cardiologist, cardiac surgeon, or PCP will usually prescribe cardiac rehab, as appropriate, approximately 6 weeks after a cardiac event and/or cardiac surgery, however, verbal or written education to encourage the patient to pursue phase II cardiac or outpatient pulmonary rehab is encouraged.

Appendix I

The following information was compiled from MicroMedex, or Brigham and Women's Pharmacy Drug Administration Index

(<http://www.bwhpikenotes.org/PatientCareServices/Pharmacy/DAGIndex.asp>). For further examples, please refer to Brigham & Women's rehabilitation department's cardiac resource manuals,

1. **Nitric Oxide (NO)** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action: Nitric oxide exerts its effects of smooth muscle relaxation by binding intracellularly to heme moieties of soluble guanylate cyclase; activating guanylate synthase, resulting in increased synthesis of cyclic guanosine 3', 5'-monophosphate (cGMP) and subsequent smooth muscle vasodilation. It increases the partial pressure of arterial oxygen (PaO₂) by dilating the better ventilated areas of the lung and redistributing blood flow from areas with low ventilation/perfusion (V/Q) ratios to areas with normal ratios.
 - b. Pharmacokinetics
 - i. Onset= Immediate
 - ii. Duration= As long as it is inhaled.
 - iii. Abrupt discontinuation may lead to rebound effect defined as an acute increase in pulmonary hypertension and decrease in oxygen saturation.
 - c. Normal Doses
The recommended initial dose is 20 ppm.
 - d. Considerations for Physical Therapy
 - i. Consult or co-treat with respiratory therapy
 - ii. Must maintain correct ratio of NO/FiO₂, therefore do not adjust FiO₂ during intervention
 - iii. Monitor: vital signs including pulse oximetry, pulmonary artery (PA) pressures, central venous pressure (CVP), pulmonary capillary wedge pressure (PCWP), or methemoglobin levels [non-oxygen binding form of hemoglobin]
 - iv. Actual FiO₂ delivered is displayed on the NO delivery system (e.g. INO Vent at Brigham & Women's Hospital)
 - a. Methemoglobinemia is defined as methemoglobin concentration > 1%. It may occur at high doses but should not occur with use of NO up to 40 ppm unless methemoglobin reductase deficiency is present. Methemoglobin levels are to be checked Q6 hr for the first 24 hr, Q12 hr for the second 24 hr, then daily thereafter. Symptoms of methemoglobinemia include: Shortness of breath, cyanosis, mental status changes, headache, fatigue, exercise intolerance, dizziness and loss of consciousness, chocolate brown color of arterial blood gas
 - b. Severe methemoglobinemia is defined as methemoglobin >50%. Healthy people may not have many symptoms with methemoglobin levels > 15%, however patients with co-

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morbidities such as anemia, cardiovascular disease, lung disease, sepsis, or presence of other abnormal hemoglobin species (e.g. carboxyhemoglobin, sulfhemoglobin or sickle hemoglobin) may experience moderate to severe symptoms at much lower levels (as low as 5-8%). Symptoms of severe methemoglobinemia include: Dysrhythmias, seizures, and coma.

2. Epoprostenol (Flolan or Prostacyclin) [\(RETURN TO MEDICATIONS\)](#)

- a. Mechanism of Action: Epoprostenol (prostacyclin) is a naturally occurring prostaglandin. It has two major pharmacologic actions: (1) direct vasodilation of the pulmonary and systemic arterial vascular beds, and (2) inhibition of platelet aggregation.
- b. Pharmacokinetics
 - i. Onset= Immediate
 - ii. Duration= Half-life is no greater than 6 minutes.
- c. Normal Doses
Infusion is initiated at 0.25 - 2 nanograms (ng)/kg/min. Doses may be increased in increments of 0.25-2 ng/kg per minute every 15 minutes until dose-limiting pharmacologic effects are elicited. Abrupt withdrawal (including interruptions in drug delivery) or sudden large reductions in dosage of epoprostenol may result in symptoms associated with rebound pulmonary hypertension, including dyspnea, dizziness, and asthenia. The dosing weight is determined prior to starting therapy and will remain the dosing weight. No readjustments of the dose based on daily weights.
- d. Considerations for Physical Therapy
 - i. Hypotension: this effect is dose related and can be reduced by decreasing the infusion rate.
 - ii. Angina/myocardial ischemia may occur in patients with severe CAD.
 - iii. Hypoglycemia in patients with diabetes.
 - iv. Increased risk of pulmonary thromboembolism or systemic embolism.
 - v. A reduction in arterial oxygen saturation has been observed in some patients with combined renal-pulmonary failure.
 - vi. Profound bradycardia and fainting; complete recovery is observed following discontinuance of the infusion.

3. Nipride or Nitroprusside (SNP) [\(RETURN TO MEDICATIONS\)](#)

- i. Mechanism of Action: Used in hypertensive crises for immediate reduction of blood pressure in patients in whom reduction is an emergency, to prevent or limit target organ damage. Causes decreased blood pressure, slight increase in heart rate, and a variable effect on cardiac output.
- b. Pharmacokinetics
 - i. Onset = Immediate (within seconds of IV administration)
 - ii. Duration = 1- 10 minutes
- c. Normal Doses:
Average dosage is 3mcg/kg/min. It usually is not given for >72 hours.

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- d. Considerations for Physical Therapy:
Physical Therapy is generally contraindicated in patients receiving this medication.
- 4. **Dopamine (dopa)** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action: Dopamine is an endogenous catecholamine. It is an immediate precursor of norepinephrine that acts by stimulating dopaminergic and adrenergic receptors of the sympathetic nervous system.
 - b. Pharmacokinetics
 - i. Onset= Immediate
 - ii. Duration= It has a plasma half life of two minutes
 - c. Normal Doses: The following are examples of normal dosing to elicit different medical/physical effects.
 - i. 1-3 mcg/kg/min (possible selective renal vasodilation-not proven in humans)
 - ii. 3-10 mcg/kg/min (inotropic and chronotropic)
 - iii. 10-20 mcg/kg/min (vasopressor)
 - d. Considerations for Physical Therapy
 - i. Specific activity orders are required if the dosage is > 5 mcg/kg/min.
 - ii. Potential for extravasation especially in patients with PVD.
- 5. **Dobutamine** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action: Dobutamine hydrochloride is a cardioselective, synthetic catecholamine with primarily β_1 activity that produces positive inotropic as well as lusitropic effects. It has a plasma half-life of two minutes and is metabolized in tissues and in the liver to form inactive metabolites that are excreted in the urine. Dobutamine is an effective positive inotropic agent for the short-term management of patients with low cardiac output associated with acute decompensated heart failure or acute myocardial infarction.
 - b. Pharmacokinetics
 - i. Onset= Immediate
 - ii. Duration= It has a plasma half life of two minutes
 - c. Normal Doses
 - i. The normal infusion rate to achieve an increase in cardiac output ranges between 2 and 15 mcg/kg/min. Tolerance may develop to the hemodynamic effects of dobutamine after 3-4 days and may require dosage increases to achieve the same hemodynamic benefit. Therefore, an increase in dose does not necessarily mean patient instability.
 - d. Considerations for Physical Therapy
 - i. Potential for extravasation especially in patients with PVD
 - ii. Tachycardia: In therapeutic doses, dobutamine increases heart rate in approximately 10% of patients with a corresponding increase in blood pressure that may occur in up to 7.5% of patients.
 - iii. Arrhythmias: Major cardiac arrhythmias are not a common problem with dobutamine, however the following have occurred: nodal escape beats, unifocal and multifocal ventricular ectopic beats, ventricular bigeminy, non-sustained and sustained ventricular tachycardia and atrial fibrillation.
 - iv. Angina: Angina, palpitations, and nonspecific chest pain have been reported in 1% to 3% of patients who receive dobutamine therapy.

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- v. Hypertension: Dobutamine can produce an increase in systolic pressure, with a 10 to 20 mmHg increase occurring in many patients given IV infusions, but is less likely to occur in patients with decompensated heart failure.
- vi. Central Nervous System: Headache may occur in 1% to 3% of patients
- vii. Gastrointestinal: Nausea has been reported in 1% to 3% of the patients.
- viii. Genitourinary effects: Urinary urgency during a high dose.
- ix. Respiratory: Hypoxemia, Dyspnea.

6. **Milrinone** ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action:
 - i. Milrinone is a positive inotrope and peripheral vasodilator, with little chronotropic activity. It exerts its effects by inhibiting phosphodiesterase production found in cardiac and vascular muscle. This activity leads in increase of intracellular ionized calcium and contractile force in heart muscles.
- b. Pharmacokinetics
 - i. Onset= Immediate
 - 1. Loading dose may be given over 10 minutes.
 - ii. Duration=
 - 1. 2.3 h (12.5 mcg/kg to 125 mcg/kg)
 - 2. 2.4 h (0.20 mcg/kg/min to 0.70 mcg/kg/min)
- c. Normal Doses
 - i. Maintenance Dose: 0.375 - 0.75 mcg/kg/min
- d. Considerations for Physical Therapy
 - i. Monitor hemodynamic trend and response to activity, especially if the dosage has been recently changed.
 - ii. BP tends to be lower in the periphery.

7. **Midodrine** ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action: (When used for symptomatic orthostatic hypotension). Midodrine is a prodrug that is converted by the body to form desglymidodrine, an alpha(1)-agonist, and exerts its action by activating the alpha-adrenergic receptors of the arteriolar and venous vasculature, thus resulting to an increase in vascular tone and elevation of the blood pressure. It has no effect on beta-adrenergic receptors.
- b. Pharmacokinetics
 - i. Onset =
 - 1. Midodrine (prodrug), Oral: time to peak concentration: about 30 minutes
 - 2. Desglymidodrine (active drug): time to peak concentration: 1-2 hours.
 - ii. Duration =
 - 1. Midodrine (prodrug): 25 minutes
 - 2. Desglymidodrine (active drug): 3- 4 hours
- c. Normal Doses = 10 mg ORALLY 3 times daily at 3-4 hr intervals (during daytime hours).
- d. Considerations for Physical Therapy

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- i. Persistent orthostatic hypotension
 - ii. Hypertension
- 8. **Inamrinone (Inocor)** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action: A positive inotropic agent with vasodilator activity. Its exact mechanism is unknown.
 - b. Pharmacokinetics
 - i. Onset= Immediate
 - ii. Duration=
 - 1. 3.6 h in general patient population
 - 2. Congestive heart failure: 5.8 h
 - c. Normal Doses
 - i. Typically 5-10 mcg/kg/min
 - d. Considerations for Physical Therapy
 - i. Hypotension
 - ii. Cardiac dysrhythmia
- 9. **Norepinephrine (Levophed)** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action:
 - i. Norepinephrine stimulates the cardiac heart inotropic and peripheral muscle vasoconstriction. It exerts its effects by stimulating both alpha and beta-1 receptors causing:
 - 1. Increased atrial and ventricular contractility
 - 2. Stimulated sinoatrial node with increase in heart rate
 - 3. Enhanced ventricular conduction
 - 4. Arteriole constriction
 - b. Pharmacokinetics
 - i. Onset=1-2 minutes
 - ii. Duration=1-2 minutes
 - c. Normal maintenance dose is 1-30 mcg/min
Doses may exceed this range in specific patients according to response and desired BP range.
 - d. Considerations for Physical Therapy:
 - i. Potential for extravasation especially in patients with PVD
 - ii. Review underlying reason for administration: Patients are likely to be hemodynamically labile.
- 10. **Neosynephrine (Neo) or Phenylephrine** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action:
 - i. Neosynephrine is a sympathomimetic agent acting primarily on alpha-adrenergic receptors causing vasoconstriction, as observed with increases in both systolic and diastolic blood pressure, and reflex bradycardia. Neosynephrine has little effect on beta- adrenergic receptors of the heart and therefore has minimal chronotropic or inotropic changes on the heart muscle.
 - b. Pharmacokinetics
 - i. Onset=immediate (I.V.)
 - ii. Duration=15 minutes (I.V.), 0.5-2 hours (I.M.)
 - c. Normal Doses

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- i. Normal IV maintenance dose is 1-300 mcg/min.
 - ii. Doses may exceed the normal range in specific patients according to response and desired BP range.
 - d. Considerations for Physical Therapy
 - Review underlying reason for administration: Patients are likely to be hemodynamically labile.
- 11. **Epinephrine (epi)** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action:
 - i. Epinephrine is a direct-acting sympathomimetic agent which stimulates both α_1 and β_1 receptors causing: increased atrial and ventricular contractility, increase in heart rate, enhanced ventricular conduction, arteriole constriction. Epinephrine provides inotropic stimulation to the heart and peripheral vasoconstriction but stimulates β_2 -adrenergic receptors resulting in relaxation of smooth muscle of the bronchial tree
 - b. Pharmacokinetics
 - i. Onset= (SC) 5-10 minutes (IV) 1-2 minutes
 - ii. Duration= 5-10 minutes
 - c. Normal Doses: Dosing dependent on reason for administration. Commonly used for hypotension, epinephrine is often administered via a continuous infusion. Epinephrine is also commonly used in anaphylaxis, bronchospasm, cardiac arrest (ACLS). Common dosing includes:
 - i. Usual starting dose = 2 mcg/min
 - ii. 0-10 mcg/min titrated to patient response
 - iii. Doses may exceed the normal range in specific patients according to response and desired BP range
 - d. Considerations for Physical Therapy
 - i. Physical Therapy is generally contraindicated when patients are receiving this medication for anaphylaxis
 - ii. Patients are likely to be hemodynamically labile. Progress activity slowly and monitor for abnormal response.
- 12. **Vasopressin** ([RETURN TO MEDICATIONS](#))
 - a. Mechanism of Action: (When used on cardiac service)
 - i. Vasopressin is used on the cardiac service for off label uses including: Vasopressin (IVP) is used as a vasoconstrictor, as an alternative to epinephrine in VF arrest. Vasopressin infusions (IV) are used to manage refractory hypotension especially related to sepsis and a low SVR. Vasopressin infusions (IV or selection intra-arterial) are used to manage bleeding esophageal varices.
 - b. Pharmacokinetics
 - i. Onset= Immediate (IV)
 - ii. Duration= Estimated systemic half-life = 10 to 20 minutes.
 - c. Normal Doses:
 - Refractory hypotension: IV infusion 0.01-0.1 units/minute titrated to response.
 - d. Considerations for Physical Therapy
 - Patient may be hemodynamically labile.

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13. Amiodarone ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action: Amiodarone is used to treat ventricular and supraventricular cardiac arrhythmias. Intravenous amiodarone is generally reserved for patients with ventricular fibrillation, hemodynamically unstable ventricular and supraventricular tachycardias, and conversion of atrial fibrillation.
- b. Pharmacokinetics
 - i. Onset= Immediate with bolus, loading dose and up-titration may take several days.
 - ii. Duration=
 - 1. Oral: time to peak concentration: 3 h to 7 h
 - 2. Amiodarone HCl: (IV), 20 days to 47 days
 - 3. Amiodarone HCl: (oral), 58 days (15 days to 142 days)
- c. Normal Doses: Depends on reason for use.
- d. Considerations for Physical Therapy
 - i. Chronicity/acuity of reason for administration.
 - ii. Stability of ECG.
 - iii. May increase Prothrombin (PT) time.
 - iv. May increase risk or advancement of AV block.

14. Lidocaine ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action: (When used IV for cardiac arrhythmias)
Lidocaine hydrochloride is used parenterally for acute treatment of ventricular arrhythmias caused by cardiac manipulation (e.g. cardiac surgery); life threatening arrhythmias, particularly of ventricular origin, which occur during acute myocardial infarction
- b. Pharmacokinetics
 - i. Onset= Immediate (When used IV for cardiac arrhythmias)
 - ii. Duration=
 - 1. Adults: (IV) 1.8 hours
 - 2. Elderly: (IV) 2.5 hours
- c. Normal Doses
 - i. Continuous infusion at 1-4 mg/min (20-50 mcg/kg/min).
 - ii. Therapeutic serum level 1-5 mcg/ml therapeutic; >5 mcg/ml, are toxic levels.
- d. Considerations for Physical Therapy
 - i. Therapeutic window
 - ii. Underlying dysrhythmia

15. Bivalirudin (Angiomax) ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action:
 - i. Bivalirudin is a direct thrombin inhibitor capable of inhibiting the action of both free and clot-associated thrombin. The systemic effect include specific inhibition of the thrombogenic activity of thrombin by specifically binding to both circulating and clot bound thrombin. This drug is commonly used for anticoagulation when patients have heparin induced thrombocytopenia, HIT positive.
- b. Pharmacokinetics
 - i. Onset= Not reported.

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- ii. Duration= Estimated half-life of 25 minutes
- c. Normal Doses: Dependent on renal function.
- d. Considerations for Physical Therapy
 - Monitor prothrombin time (PT), activated partial thromboplastin time (aPTT), or thrombin time (PTT).

16. Heparin ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action:
 - i. Heparin is a glycosaminoglycan that inhibits the mechanisms that induce the clotting of blood and the formation of stable fibrin clots at various sites in the normal coagulation system. Thrombosis is blocked through inactivation of activated Factor X and inhibition of prothrombin's conversion to thrombin. This also prevents fibrin formation from fibrinogen during active thrombosis.
- b. Pharmacokinetics
 - i. Onset= Subcutaneous: time to peak concentration, 2 h to 4 h
 - ii. Duration= Estimated half life is variable (1/2 to 2 hours).
- c. Normal Doses: Varies depending on reason for administration. Refer to PT considerations for observed/recommended monitoring values.
- d. Considerations for Physical Therapy
 - i. aPTT is 1.5 to 3 times initial baseline value (not exceeding an aPTT of 100 seconds).
 - ii. Therapeutic range dependent on use:
 - 1. <50 seconds is generally considered sub-therapeutic
 - 2. PTT suprathreshold, >120, monitor for signs of active bleeding, discussion with clinical specialist, supervisor, appropriate team member. If PTT >120seconds and active bleeding, PT treatments should be held for 1/2 hour if drug administration has been titrated and bleeding stopped.

17. Coumadin (Warfarin) ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action: Blocking regeneration of vitamin K(1) epoxide, thus inhibiting synthesis of vitamin K-dependent clotting factors which include factors 2, 7, 9 and 10, and the anticoagulant proteins C and S .
- b. Pharmacokinetics
 - i. Onset= Oral: time to peak concentration, within 4 h
 - ii. Duration= Estimated half life: approximately 1 week
- c. Normal Doses: Oral: Initial doses usually range from 2 to 5 mg Q24hrs. Maintenance doses usually range from 2 to 10 mg once daily.
- d. Considerations for Physical Therapy
 - i. Monitor international normalized ratio (INR) to determine if the patient's INR is within therapeutic range as determined by the MD. In general INR values of 2-3 are considered therapeutic with values 2.5-3.5 therapeutic for patients with recurrent thrombosis.
 - ii. Increased risk of bleeding is more likely to occur during the starting period and with a higher dose (resulting in a higher INR). Risk factors for bleeding include: High intensity of anticoagulation (INR greater than 4.0), age 65 or greater, highly variable INRs, history of gastrointestinal

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bleeding, hypertension, cerebrovascular disease, serious heart disease, anemia, malignancy, trauma, renal insufficiency, concomitant drugs, and long duration of warfarin therapy.

18. **Enoxaparin** ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action: Enoxaparin is a low molecular weight heparin, which has anti-thrombotic properties. It is prepared by degradation of unfractionated (conventional) heparin of porcine intestinal mucosa origin has anti-Factor Xa and anti-thrombin (anti-Factor IIa) activities.
- b. Pharmacokinetics
 - i. Onset= Not Reported
 1. Dosing is based on weight, age, and reason for administration.
 - ii. Duration= Estimated half-life is 7 h
- c. Normal Doses: Depends on reason for administration.
- d. Considerations for Physical Therapy
 - i. Appropriate dosing may be monitored using Anti-Xa levels. Peak Anti-Xa levels 3-6 hours after the third dose and should be 0.5 to 1.1. Please note that utility of an anti-Xa level as a marker for safety and efficacy is controversial and the decision to obtain an anti-Xa level is based on the clinical situation and physician comfort, therefore you may not be able to refer to these lab values and should consider this medication to be similar to heparin.

19. **Streptokinase** ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action:
 - i. Streptokinase is a potent thrombolytic agent used for multiple medical diagnosis and during medical/surgical interventions. It is derived from the culture filtrate of beta-hemolytic streptococci of Lancefield group C. It initiates activation of endogenous fibrinolytic system upon binding to plasminogen, thus producing a complex that possesses activator properties and accelerates the further transformation of plasminogen into the proteolytic and fibrinolytic plasmin.
- b. Pharmacokinetics:
 - i. Onset= Not reported
 - ii. Duration= Estimated half life is 80 minutes
- c. Considerations for Physical Therapy
 - i. Physical therapy is contraindicated in patients currently receiving this medication.

20. **Natrecor (Nesiritide, BNP)** ([RETURN TO MEDICATIONS](#))

- a. Mechanism of Action:
 - i. Natrecor is a recombinant form of human B-type natriuretic peptide which binds to receptors of the vascular smooth muscle and endothelial cells. Binding increases intracellular guanosine 3'5'-cyclic monophosphate (cGMP) and causes smooth muscle relaxation. Infusion of Natrecor results in arterial and venous dilation, enhanced sodium excretion, and suppression of the renin-angiotensin-aldosterone and sympathetic nervous systems. This action results in the following hemodynamic effects:

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decreases (BP, SVR, PVR, PA, PCWP, CVP), increases (CO, CI), no change in HR

- b. Pharmacokinetics
 - i. Onset= Immediate (IV)
 - ii. Duration= Systemic: 18 min
- c. Normal Doses
Infuse at a rate of 0.01 mcg/kg/min after initial push.
- d. Considerations for Physical Therapy
 - i. Potential for severe hypotension with diuresis.
 - ii. Monitor closely when dosages are changed.

21. IV nitroglycerin (NTG) [\(RETURN TO MEDICATIONS\)](#)

- a. Mechanism of Action:
 - i. IV nitroglycerine is an organic nitrate whose pharmacokinetics result in relaxation of vascular smooth muscle resulting predominantly in venous dilation, with a dose dependant arterial dilation.
- b. Pharmacokinetics
 - i. Onset = Immediate (Initial dose of 5 mcg/min).
 - ii. Duration = Estimated half-life is 1-4 minutes.
- c. Normal Doses
Range 5-200 mcg/min. Most patients can be managed by an increase in 5-10 mcg/min increments every 5 minutes until the desired clinical outcome (decrease in blood pressure, relief of angina pain) is achieved.
- d. Considerations for Physical Therapy
Monitor for hypotension and arrhythmias

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References

1. WHO | International Classification of Functioning, Disability and Health (ICF). .
<http://www.who.int/classifications/icf/en/>. Accessed 5/9/2009, 2009.
2. *International Classification of Functioning, Disability, and Health*. Geneva: World Health Organization; 2001:299.
3. Boldt C, Grill E, Wildner M, et al. ICF Core Set for patients with cardiopulmonary conditions in the acute hospital. *Disabil Rehabil*. 2005;27(7-8):375-380.
4. Papaioannou TG, Stefanadis C. Basic Principles of the Intraaortic Balloon Pump and Mechanism Affecting Its Performance. *ASAIO Journal*. 2005;51(3):296-300.
5. Ciesla ND, Murdock KR. Lines, Tubes, Catheters, and Physiologic Monitoring in the ICU. *Cardiopulmonary Physical Therapy*. 2000;11(1):16-25.
6. Lowy J, Freedman R. ACP Medicine Cardiovascular Medicine: VII Pacemaker Therapy. .
<https://carmenwiki.osu.edu/download/attachments/8488046/Pacemakers.pdf?version=1>. Updated 2004. Accessed 4/2009, 4/16/09.
7. Massachusetts Department of Motor Vehicles. Cardiovascular and Pulmonary Disease Policy Statement: As of November 2007. . Updated 2007. Accessed 4/2009, 4/16/09.
8. Chung MK. Cardiac surgery: postoperative arrhythmias. *Crit Care Med*. 2000;28(10 Suppl):N136-44.
9. Olbrecht VA, Barreiro CJ, Bonde PN, et al. Clinical Outcomes of Noninfectious Sternal Dehiscence After Median Sternotomy. *The Annals of Thoracic Surgery*. 2006;82(3):902-907.
Standard of Care: Cardiac

10. Kuo J, Butchart EG. Sternal wound dehiscence. *Care of the Critically Ill*. 1995;11(6):244-248.
11. Tuten HR, Young DC, Douoguih WA, Lenhardt KM, Wilkerson JP, Adelaar RS. Adhesive capsulitis of the shoulder in male cardiac surgery patients. *Orthopedics*. 2000;23(7):693-696.
12. Perez M, Shaw D. Are inpatient upper extremity movement precautions following median sternotomy justified? *Cardiopulmonary Physical Therapy*. 2003;14(4):28.
13. Iron G, Benefield P, Bolton R, Collins G, Davidson K. Effects of Shoulder Range of Motion on Sternal Skin Stress. *Acute Care Perspectives*. 2005;15(3):13-14.
14. Irion GL, Boyte B, Ingram J, et al. Sternal Skin Stress Produced by Functional Upper Extremity Movements. *Acute Care Perspectives*. 2007;16(3):1-5.
15. El-Ansary D, Waddington G, Adams R. Relationship between pain and upper limb movement in patients with chronic sternal instability following cardiac surgery. *Physiotherapy Theory & Practice*. 2007;23(5; 5):273-280.
<http://search.ebscohost.com/login.aspx?direct=true&db=nyh&AN=27240769&site=ehost-live>.
16. ElAnsary D, Waddington G, Adams R. Trunk stabilisation exercises reduce sternal separation in chronic sternal instability after cardiac surgery: a randomised cross-over trial. *Australian Journal of Physiotherapy*. 2007;53(4):255-260.
17. McGregor WEa, Trumble DRb, Magovern JAb. MECHANICAL ANALYSIS OF MIDLINE STERNOTOMY WOUND CLOSURE. *Journal of Thoracic & Cardiovascular Surgery*. 1999;117(6):1144-1150.

Standard of Care: Cardiac

18. Hultman CS, Culbertson JH, Jones GE, et al. Thoracic reconstruction with the omentum: indications, complications, and results. *Ann Plast Surg.* 2001;46(3):242-249.
19. Ghazi BH, Carlson GW, Losken A. Use of the greater omentum for reconstruction of infected sternotomy wounds: a prognostic indicator. *Ann Plast Surg.* 2008;60(2):169-173.
20. Braunwald E. Clinical Manifestations of Heart Failure. In: *Heart Disease: A Textbook of Cardiovascular Medicine.* 2nd ed. Philadelphia: W.B. Saunders Company; 1984:488.
21. Acute Care Section - APTA. Cardiovascular Monitoring Guidelines. .
<http://www.acutept.org/cvguidelines.pdf>. Accessed 3/14, 2009.
22. Tabet JY, Meurin P, Ben Driss A, et al. Determination of exercise training heart rate in patients on beta-blockers after myocardial infarction. *Eur J Cardiovasc Prev Rehabil.* 2006;13(4):538-543.
23. Myers J, Tan SY, Abella J, Aleti V, Froelicher VF. Comparison of the chronotropic response to exercise and heart rate recovery in predicting cardiovascular mortality. *Eur J Cardiovasc Prev Rehabil.* 2007;14(2):215-221.
24. Green CP, Porter CB, Bresnahan DR, Spertus JA. Development and evaluation of the Kansas City Cardiomyopathy Questionnaire: a new health status measure for heart failure. *J Am Coll Cardiol.* 2000;35(5):1245-1255.
25. DeTurk WE, Cahalin LP. *Cardiovascular and Pulmonary Physical Therapy: An Evidence-Based Approach.* McGraw-Hill Companies, Inc.; 2004:721.

Standard of Care: Cardiac

26. Hillegass EA, Sadowsky HS. *Essentials of Cardiopulmonary Physical Therapy*. 2nd ed. Philadelphia: W.B. Saunders Company; 2001:868.
27. Petrucci RJ, Truesdell KC, Carter A, et al. Cognitive dysfunction in advanced heart failure and prospective cardiac assist device patients. *Ann Thorac Surg*. 2006;81(5):1738-1744.
28. Bijur PE, Silver W, Gallagher EJ. Reliability of the visual analog scale for measurement of acute pain. *Acad Emerg Med*. 2001;8(12):1153-1157.
29. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. *American Journal of Respiratory & Critical Care Medicine*. 2002;166(1):111-117.
30. ENRIGHT PL, SHERRILL DL. Reference Equations for the Six-Minute Walk in Healthy Adults. *Am J Respir Crit Care Med*. 1998;158(5):1384-1387.
31. Gibbons WJ, Fruchter N, Sloan S, Levy R. Reference Values for a Multiple Repetition 6-Minute Walk Test in Healthy Adults Older Than 20 Years. *J Cardiopulm Rehabil*. 2001;21(2):87-93.
32. Guyatt GH, Sullivan MJ, Thompson PJ, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. *Can Med Assoc J*. 1985;132(8):919-923.
33. Noonan V, Dean E. Submaximal Exercise Testing: Clinical Application and Interpretation. *Phys Ther*. 2000;80(8):782-807.
34. Opasich C, De Feo S, Pinna GD, et al. Distance walked in the 6-minute test soon after cardiac surgery: toward an efficient use in the individual patient. *Chest*. 2004;126(6):1796-1801.

Standard of Care: Cardiac

35. Troosters T, Gosselink R, Decramer M. Six minute walking distance in healthy elderly subjects. *Eur Respir J*. 1999;14(2):270-274.
36. Wise RA, Brown CD. Minimal clinically important differences in the six-minute walk test and the incremental shuttle walking test. [Review] [36 refs]. *Copd:Journal of Chronic Obstructive Pulmonary Disease*. 2005;2(1):125-129.
37. Rostagno C, Olivo G, Comeglio M, et al. Prognostic value of 6-minute walk corridor test in patients with mild to moderate heart failure: comparison with other methods of functional evaluation. *Eur J Heart Fail*. 2003;5(3):247-252.
38. Rostagno C, Galanti G, Romano M, Chiostrì G, Gensini GF. Prognostic value of 6-minute walk corridor testing in women with mild to moderate heart failure. *Ital Heart J*. 2002;3(2):109-113.
39. Cahalin LP, Mathier MA, Semigran MJ, Dec GW, DiSalvo TG. The six-minute walk test predicts peak oxygen uptake and survival in patients with advanced heart failure. *Chest*. 1996;110(2):325-332.
40. Bohannon RW. Reference values for the five-repetition sit-to-stand test: a descriptive meta-analysis of data from elders. *Perceptual & Motor Skills*. 2006;103(1):215-222.
41. Bohannon RW. Sit-to-stand test for measuring performance of lower extremity muscles. *Perceptual & Motor Skills*. 1995;80(1):163-166.
42. American Physical Therapy Association. *Guide To Physical Therapy Practice*. Second ed. Alexandria, Virginia: American Physical Therapy Association; 2003:738.

Standard of Care: Cardiac

43. Randall KE, McEwen IR. Writing Patient-Centered Functional Goals. *Phys Ther.* 2000;80(12):1197-1203.