

Ventricular Assist Devices (VAD): Updates and Interventions Across Settings

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Objectives

Upon completion of this course, attendees will be able to:

1. Describe the indications for ventricular assist devices and review the types of ventricular assist devices.
2. Review current literature and common practice for medical professionals.
3. Discuss the common complications surrounding ventricular assist devices in addition to possible complication prevention.
4. Identify areas of intervention that physical therapists could apply across inpatient/acute care, home health, and outpatient settings.

Heart Failure

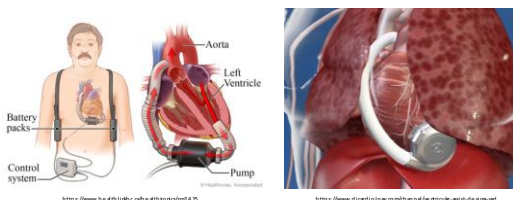
- AHA– “when the heart muscle is weakened and cannot pump enough blood to meet the body’s needs for blood and oxygen.”
- Decreased cardiac output secondary to:
 - Increased afterload
 - Increased preload
 - Decreased contractility

NYHA Classification System

Class	Description
I	No limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea (shortness of breath).
II	Slight limitation of physical activity. Comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea (shortness of breath).
III	Marked limitation of physical activity. Comfortable at rest. Less than ordinary activity causes fatigue, palpitation, or dyspnea.
IV	Unable to carry on any physical activity without discomfort. Symptoms of heart failure at rest. If any physical activity is undertaken, discomfort increases.

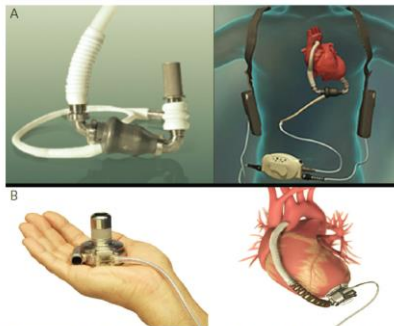
Ventricular Assist Device (VAD)

- Battery operated, mechanical pump that helps to maintain the pumping ability of the heart



Indications

- NYHA Class IV end-stage LV Heart failure
- EF <15%
- Maximized pharmacological interventions
- Conference to discuss candidacy
- Destination Therapy
 - 60-90 days of optimal medical management
 - Life expectancy <2 years
 - Non cardiac transplant candidate



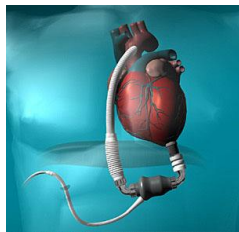
A. HeartMate II device; B. HeartWare HVAD. A. Courtesy of Thoratec, Pleasanton, CA, with permission; B. Courtesy of HeartWare, Framingham, MA.
<http://www.dcp.com/~/media/Default.aspx?cat=devices&page=heart-failure>

Statistics^{4,5}

- 16,000 implanted in US
- 2,400 implanted annually
- 1 year survival 80%, 2 year survival 70%, 5 year survival 59%
- Exercise capacity can normalize in the trained VAD patient

HeartMate II

Axial flow, larger profile, pre-peritoneal pocket



<http://www.thoratec.com/art/cmg/heart-failure/heart-failure-implantation/heart-failure-implantation.html>



<http://www.gps.com/~/media/Default.aspx?cat=devices&page=heart-failure>

HeartMate III

Centrifugal pump, implanted directly opposing heart, more accurate flow estimation (using patient hematocrit)
 **remains investigational



<http://www.thoratec.com/~/media/Default.aspx?cat=devices&page=heart-failure>



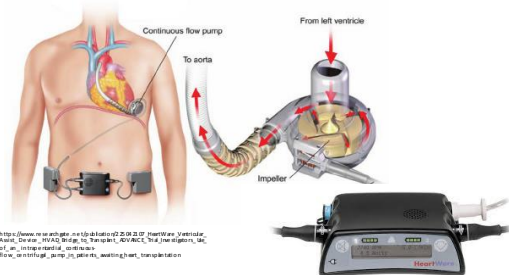
<http://www.thoratec.com/~/media/Default.aspx?cat=devices&page=heart-failure>

Changes from HM II to HM III

- HM III has two cables:
 - Pump cable is attached to the pump and goes through the skin.
 - Modular cable that attaches to the pump cable and connects to the controller
- HM III control electronics are in the implanted pump
- HM III parameters and settings are stored in the pump
- HM III has software in the pump and the controller
- HM III operates with an artificial pulse
 - Activates every 2 seconds (30 per min)
- HM III has a more accurate flow estimation
- HM III has a longer battery life secondary to increased efficiency

HeartWare

Centrifugal pump, implanted directly opposing heart, more accurate flow estimation



<http://www.heartware.com/~/media/Default.aspx?cat=devices&page=heart-failure>

<http://www.heartware.com/~/media/Default.aspx?cat=devices&page=heart-failure>



Updates with HW Controller 2.0

- Upgraded connections
 - 12 o'clock alignment, red dot
 - Metal connections for improved durability
- Longer battery life with less frequent changes needed
- Improved estimation of patient flow
- AC power adapter now 2 prong, improved compatibility
- Improve software updates with more information visible from controller



Common Complications

- Bleeding complications
- Thromboembolic events
- Infections
- Aortic insufficiency
- Right ventricular failure
- Arrhythmias
- LVAD Malfunction or failure



Application Across Settings



PT Interventions: Hospital Cardiac Rehab Phase I

- Pre-op Strengthening and Education
- Post-op ICU Mobility
- Post-op Step-down unit
 - Education on changing from wall to battery
 - changes with speed changes
 - changes with exercise
 - Mobility and D/C Recommendations
 - Strengthening
 - Balance Training



PT Interventions: Outpatient

- Cardiac Rehabilitation – Phase II and III
- PT Based Cardiopulmonary Rehabilitation
- Outpatient clinics



Medicare Reimbursement Diagnoses for Phase II Cardiac Rehab

- Stable angina
- Heart transplant
- s/p stent
- s/p CABG
- s/p heart valve replacement
- s/p MI
- Heart failure with EF \leq 35%*
 - LVAD*

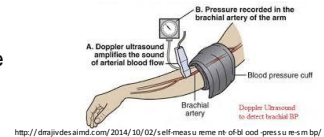
Cardiac Rehabilitation Staffing

- Medical director
- Administrative director
- Exercise specialist
- Dietitian
- Behavioral specialist
- Nurse

- (Pharmacist)
- (Physical Therapist)

Required Equipment

- Track or treadmills
- Stationary bicycles, NuStep, UBE
- Rowing machines
- Dumbbells, cuff weights, Therabands, other strength training equipment
- Ambulatory assistive devices
- Oximeters and oxygen equipment
- BP cuffs
- Doppler
- EKG machine



Emergency Management

- Written policies & procedures
- Equipment such as AED, oxygen, snacks, glucometer
- Trained personnel should be BLS certified, preferably ACLS certified
- Annual competencies of personnel, emergency practice sessions
- Inspection of facility by outside agency, e.g., JCAHO, state agency, AACVPR program certification

Goals of Phases - Cardiac Rehabilitation

- Phase II– Outpatient Monitored (Reimbursed)
 - Individually tailor program
 - Increased focus on patient education
 - Increased focus on psychosocial aspects, anxiety, stress
 - Risk modification
 - Demonstrate increased exercise tolerance
 - Improved sense of self-efficacy, QOL, perceived well-being
 - Demonstrate independence in own management
 - Typical length = ~ 3x/week x 12 weeks (36 sessions)

Goals of Phases - Cardiac Rehabilitation

- Phase III– Outpatient, Maintenance (self-pay)
 - Patient requires little supervision
 - Patient demonstrates independence & adherence with program
 - Able to self-monitor
 - Patient with normal/controlled hemodynamic response to exercise
 - Weeks to months to a lifetime – most days of the week (minimum 3x/week)

PT Based Cardiopulmonary Rehab

- Multidisciplinary approach
- Stress management
- Breathing techniques
- Energy conservation techniques
- Patient education
- Exercise training



PT Based Cardiopulmonary Rehab

- Staffing
 - Physical Therapists
 - Physical Therapy Assistants
 - Respiratory Therapists
 - Dietician
 - Clinical Health Counselor
 - Physician/Medical Director
- Equipment and Emergency Procedures similar to CR



PT Based Cardiopulmonary Rehab

- Referrals based on any cardiac and/or pulmonary diagnosis
- Undergo PT Evaluation prior to participation
- Frequency and duration determined based on patient needs
 - Group (3-5 days/week)
 - Individual (2-3 days/week)



Group Program

- Heart Failure/Cardiac Rehab
 - 2.5 hours/day, 3 days/week
 - Continuous monitoring of vitals
 - BP, HR, SpO2, FiO2, pain, weight, BG, RPE
 - Progressive endurance training AND resistance training
 - Group exercise classes
 - Patient education lectures



Outpatient Clinics (Other)

- Orthopedic
 - Amputees
- Neuro
 - Stroke
- Monitor flow and RPE with activity*



Home Health

- Safety assessment
 - Falls
 - VAD equipment management
- Strength
- Balance
- General mobility needs
- Monitor flow and RPE*



PT Evaluation & Treatment



Subjective

- Chart review
 - Recent hospitalizations
 - Co-morbidities
 - Lines/leads
 - Medications
 - Imaging/diagnostic studies
- History
 - Onset
 - Progression
 - Medical history
 - Greatest difficulties
 - Prior and current functional level
 - Goals

Objective

- Observation/ Palpation
- ROM
- Strength, Flexibility
- Gait pattern
- Auscultation
- Jugular Venous distention
- Edema



https://en.wikipedia.org/wiki/Jugular_venous_pressure

Objective

- Resting Vital Signs
 - LVAD settings (flow, speed, power, batteries)
- Breathing pattern
 - Pursed-lip, diaphragmatic, paced breathing
- Outcome measures
 - Exercise capacity
 - QOL
 - Depression
 - Shortness of breath



<http://heartmateii.com/heartmate-ii-system.aspx>

Contraindications for Participation ¹¹

- Unstable angina
- Uncontrolled HTN: resting SBP \geq 180 mmHg and/or resting DBP \geq 110 mmHg
- Symptomatic orthostatic BP drop of $>$ 20 mmHg
- Significant aortic stenosis
- Uncontrolled arrhythmia
- Uncontrolled sinus tach
- Uncompensated HF
- Third degree AV block without pacer

Contraindications cont. ¹¹

- Active pericarditis or myocarditis
- Recent embolism
- Acute thrombophlebitis
- Acute systemic illness or fever
- Uncontrolled diabetes
- Orthopedic condition that would prohibit exercise
- Other metabolic conditions such as acute thyroiditis, hypokalemia, hyperkalemia, or hypovolemia

Considerations for Patients with LVADs

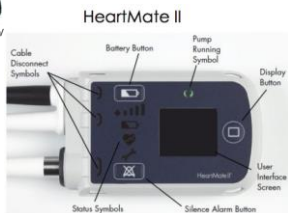
- Drivelines and power cords
- Lab values
 - INR, LDH
- Sternal precautions
- Fall prevention
- Stroke warning signs
 - F.A.S.T.
- Cardiac signs and symptoms
 - Arrhythmias

Considerations for LVADs cont.



<http://www.lvad.nl/levan-neteen-lvad/water-doen-bij-alarms/>

- Battery life
- Back-up controller and batteries
- Check settings



<http://www.60secondem.com/abcsvad-antwef/>

Alarms

Blank Display, VAD stopped, Critical Battery
High Watt
Electrical Fault
Low Flow
Suction Call
Low Battery

Considerations for LVADs cont.^{12,13}

- Continuous flow pumps
 - Loss of standard BP
 - Narrow pulse pressure
 - SBP in 80s-90s, DBP 50s-70s
 - MAP is key parameter (60-80 mmHg at rest, <100 mmHg to exercise)
 - Loss or inaccurate HR and SpO₂
- Subjective scales
- Flow (estimation of cardiac output)
- *TREAT PATIENT

Endurance Training¹⁴⁻¹⁶

- Warm-up and cool down periods are key
- Increase duration and frequency *before* intensity
- Goal is to achieve 20-60 minutes of moderate physical activity (RPE 12-14), 4-5 days/week (150 min/week)
- ACA/AHA recommendations include:
 - Begin at bouts of 2-6 min with 1-2 min rest at 40-60% VO₂ max
 - Gradually increase until pt. tolerates 30 min of continuous activity
 - 15-30 minutes, 3-5 days/week at RPE 10-13
- Mode
 - Most studies done with bicycle ergometer
 - Progressive ambulation
 - NuStep

Interval Training¹⁷

- Studies find interval training is beneficial to patients with HF by improving:
 - Exercise capacity
 - Oxygen uptake
 - QOL
 - Suppressing oxidative stress
 - Suppressing inflammation
- Typical prescription is 30 sec work: 60 sec recovery

Barriers to Ambulation or Physical Activity

- Slow or fast gait speed
- Physical effort too demanding
- Anxiety
- Poor balance
- Lack of assistive device
- Dyspnea
- Time consuming/Cost
- Fatigue
- Co-morbidities

Warning Sxs of Limited Exercise Tolerance

- Low anginal threshold
- Excessive dyspnea
- Leg claudication or other pain
- Pallor, facial distress
- Lightheadedness, dizziness
- Excessive fatigue lasting > 1-2 hours

Resistance Training¹⁸⁻¹⁹

- Moderate to slow, controlled speed through complete ROM
- Avoid Valsalva
- Should initially be 1 set of 10-15 repetitions at low intensity
- Involve major muscle groups of both UE and LE
- Frequency: 2x/week with 48 hours between major muscle groups

Resistance Training

- Group exercise can be an appropriate option for resistance training
 - Seated
 - Use of light dumbbells, cuff weights, Therabands
 - Incorporate posture and flexibility exercises

Functional Mobility

- Recommend appropriate assistive devices
- Demonstrate and practice techniques
- Educate on energy conservation



<https://justwalkers.com/the-roller-roller-blue.html>

Patient Education

- Anatomy and physiology
- Lifestyle changes
- Medications
- Self-monitoring of vital signs, especially RPE
- Energy conservation
- Medical tests, procedures
- Sleep strategies
- Management of co-morbidities (pulmonary disease, DM, cholesterol)

Patient Education

- Stress management and relaxation techniques
- Smoking cessation
- Edema
- Nutrition, healthy eating, label reading
- Breathing exercises
- Home exercise



<https://beta.cdn.grubhub.com/food/food-label-reading>



Outcomes

- Measured pre- and post-intervention:
 - Clinical: improved exercise tolerance, lipid levels
 - 6MWT, blood tests, gait speed, functional tests
 - Quality of Life: improved symptom management
 - Behavioral: cessation of cigarette smoking, compliance with exercise, attendance
 - Psychosocial: improved sense of well-being, reduced stress, reduced depression, improved self-efficacy



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