**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**

<table>
<thead>
<tr>
<th>Class</th>
<th>Patient Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No limitation of physical activity. Ordinarily active without fatigue, palpitation, dyspnea (shortness of breath).</td>
</tr>
<tr>
<td>II</td>
<td>Slight limitation of physical activity. Comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea (shortness of breath).</td>
</tr>
<tr>
<td>III</td>
<td>Marked limitation of physical activity. Comfortable at rest. Less than ordinary activity causes fatigue, palpitation, or dyspnea.</td>
</tr>
<tr>
<td>IV</td>
<td>Unable to carry on any physical activity without discomfort. Symptoms of heart failure at rest. If any physical activity is undertaken, discomfort increases.</td>
</tr>
</tbody>
</table>

**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
Statistics\textsuperscript{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

HeartMate III

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

**remains investigational**

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
**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
  - Education on flow
    - 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 ≤ 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 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)

**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)

Goals of Phases - Cardiac Rehabilitation

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
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

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

Contraindications for Participation

- Unstable angina
- Uncontrolled HTN: resting SBP ≥ 180 mmHg and/or resting DBP ≥ 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.

- 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.

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

Considerations for LVADs cont.\textsuperscript{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

Interval Training\textsuperscript{17}

- 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

Endurance Training\textsuperscript{14-16}

- 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% VO\textsubscript{2} 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

Alarms

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

McGuirk, Schiltgen
LVAD Across the Settings
October, 2017
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 Training $$^{18-19}$$

- 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

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
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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8. Blue, L. Molinari, V. HeartMate Left Ventricular Assist System: System Overview. Hands on Practicum; Oral Presentation at Duke University Health System Meeting; August 2017; Durham, NC.