VADs Aren’t BAD: Emergency Care for the Patient on Mechanical Circulatory Support

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OBJECTIVES

▪ List indications for Mechanical Circulatory Support

▪ Identify types and function of Mechanical Circulatory Support

▪ Discuss emergency care for the patients with Mechanical Circulatory Support
WHO HAS HEART FAILURE?

- Approximately 5.7 million persons in the United States have HF with the numbers increasing.

- In the U.S., >650,000 new HF cases are diagnosed annually.

- The lifetime risk of developing HF is 20% for Americans ≥40 years of age.

- HF incidence increases with age:
  - 20 per 1,000 individuals 65 to 69 years of age
  - >80 per 1,000 individuals >85 years of age
HEART FAILURE (HF)

“HF is a complex clinical syndrome that results from any structural or functional impairment of ventricular filling or ejection of blood.”

2013 ACCF/AHA Guideline for the Management of Heart Failure : A Report of the American College of Cardiology Foundation/American Heart Association of Practice Guidelines http://circ.ahajournals.org/content/early/2013/06/03/CIR.0b013e31829e8776.citation
TERMS TO KNOW

- Heart Failure with Preserved Ejection Fraction (HFpEF)
  - diastolic failure
  - EF ~ >50%

- Heart Failure with Reduced Ejection Fraction (HFrEF)
  - systolic failure
  - EF ≤ 40%

- HFrEF and HFpEF each make up about half of the overall HF burden.
HFpEF: Diastolic heart failure

HFrEF: Systolic heart failure

Aorta

Thick, stiff heart muscle

Right ventricle

Left ventricle

Thin, weak heart muscle
HEART FAILURE SYMPTOMS

Dilated pupils, a sympathetic nervous system response
Skin pale, gray, or cyanotic
Dyspnea, SOBOE is early symptom from pulmonary congestion
Orthopnea, cannot breathe unless sitting up
Crackles, wheeze are adventitious breath sounds
Cough, frothy pink or white sputum
Decreased blood pressure stimulates sympathetic nervous system, which acts on heart to increase rate and increase force of contraction
Nausea and vomiting as peristalsis slows and bile and fluids back up into stomach
Ascites, fluid in peritoneal cavity
Dependent, pitting edema, in sacrum, legs

Anxiety, gasping from pulmonary congestion
Falling O₂ saturation
Confusion, unconsciousness from decreased O₂ to brain
Jugular vein distention from venous congestion
Infarct, may be cause of decreased cardiac output
Fatigue, weakness from decreased cardiac output
S₃ gallop, tachycardia
Enlarged spleen and liver from venous congestion. This causes pressure on breathing
Decreased urine output
Weak pulse Cool, moist skin

http://medical-dictionary.thefreedictionary.com/heart+failure
STAGES, PHENOTYPES AND TREATMENT OF HF

**At Risk for Heart Failure**

**STAGE A**
- At high risk for HF but without structural heart disease or symptoms of HF

  - e.g., Patients with:
    - HTN
    - Atherosclerotic disease
    - DM
    - Obesity
    - Metabolic syndrome
    - Patients Using cardiotoxins
    - With family history of cardiomyopathy

**STAGE B**
- Structural heart disease but without signs or symptoms of HF

  - e.g., Patients with:
    - Previous MI
    - LV remodeling including LVI and low EF
    - Asymptomatic valvular disease

**Heart Failure**

**STAGE C**
- Structural heart disease but with prior or current symptoms of HF

  - e.g., Patients with:
    - Known structural heart disease and HF signs and symptoms

**STAGE D**
- Refractory HF

  - e.g., Patients with:
    - Marked HF symptoms at rest
    - Recurrent hospitalizations despite GDMT

**THERAPY**

**At Risk for Heart Failure**

- **Goals**
  - Heart healthy lifestyle
  - Prevent vascular, coronary disease
  - Prevent LV structural abnormalities
- **Drugs**
  - ACEI or ARB in appropriate patients for vascular disease or DM
  - Statins as appropriate

**Heart Failure**

- **Goals**
  - Control symptoms
  - Improve HRQoL
  - Prevent hospitalization
  - Prevent mortality
- **Drugs**
  - Diuretics for fluid retention
  - ACEI or ARB
  - Beta blockers
  - Aldosterone antagonists
- **Options**
  - Advanced care measures
  - Heart transplant
  - Chronic inotropes
  - Temporary or permanent MCS
  - Experimental surgery or drugs
  - Palliative care and hospice
  - ICD deactivation

**STAGE C**

**THERAPY**

- **Goals**
  - Prevent HF symptoms
  - Prevent further cardiac remodeling
- **Drugs**
  - ACEI or ARB as appropriate
  - Beta blockers as appropriate
- **In selected patients**
  - ICD
  - Revascularization or valvular surgery as appropriate

**STAGE D**

**THERAPY**

- **Goals**
  - Control symptoms
  - Patient education
  - Prevent hospitalization
  - Prevent mortality
- **Drugs**
  - Diuretics for selected patients
  - Hydralazine/diltiazem dinitrate
  - ACEI and ARB
  - Digoxin
- **In selected patients**
  - CRT
  - ICD
  - Revascularization or valvular surgery as appropriate

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STAGES, PHENOTYPES AND TREATMENT OF HF

STAGE A
At high risk for HF but without structural heart disease or symptoms of HF
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THERAPY
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STAGE C
Structural heart disease with prior or current symptoms of HF
- e.g. Patients with:
  - Known structural heart disease and HF signs and symptoms

THERAPY
- Goals
  - Control symptoms
  - Patient education
  - Prevent hospitalization
  - Prevent mortality
- Drugs for routine use
  - Diuretics for fluid retention
  - ACEI or ARB
  - Beta blockers
  - Aldosterone antagonists
- Strategies
  - Identification of comorbidities
- Treatment
  - Diuresis to relieve symptoms of congestion
  - Follow guideline driven indications for comorbidities, e.g., HTN, AF, CAD, DM
  - Revascularization or valvular surgery as appropriate
- In selected patients
  - CRT
  - ICD
  - Revascularization or valvular surgery as appropriate

Heart Failure
- Refractory symptoms of HF at rest, despite GDMT
- Refractory HF
- e.g. Patients with:
  - Marked HF symptoms at rest
  - Recurrent hospitalizations despite GDMT

THERAPY
- Goals
  - Control symptoms
  - Improve HRQOL
  - Reduce hospital readmissions
  - Establish patient’s end-of-life goals
- Drugs for HF
  - Hydralazine
  - ACEI and ARB
  - Digoxin
- Strategies
  - Identification of comorbidities
- Treatment
  - Diuresis to relieve symptoms of congestion
  - Follow guideline driven indications for comorbidities, e.g., HTN, AF, CAD, DM
  - Revascularization or valvular surgery as appropriate
- In selected patients
  - CRT
  - ICD
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THERAPY
- Goals
  - Advanced care measures
  - Heart transplant
  - Chronic infotropes
  - Temporary or permanent MCS
  - Experimental surgery or drugs
  - Palliative care and hospice
  - ICD deactivation

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Refractory HF
- e.g. Patients with:
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  - Follow guideline driven indications for comorbidities, e.g., HTN, AF, CAD, DM
  - Revascularization or valvular surgery as appropriate
- In selected patients
  - CRT
  - ICD
  - Revascularization or valvular surgery as appropriate
WHY NOT DIRECTLY TRANSPLANT

- Long wait
- Increased demand
- Limited donor hearts
### Implants: June 2006 – December 2013, n = 10542

<table>
<thead>
<tr>
<th>Year</th>
<th>Cont Intra Pump</th>
<th>Puls Intra TAH</th>
<th>Puls Intra Pump</th>
<th>Puls Para Pump</th>
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<td>1</td>
<td>1</td>
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<td>18</td>
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<td>2009</td>
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<td>2010</td>
<td>1581</td>
<td>29</td>
<td>13</td>
<td>29</td>
</tr>
<tr>
<td>2011</td>
<td>1838</td>
<td>26</td>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>2012</td>
<td>2207</td>
<td>41</td>
<td>0</td>
<td>54</td>
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<tr>
<td>2013</td>
<td>2420</td>
<td>66</td>
<td>0</td>
<td>30</td>
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</tbody>
</table>

**Graph:**
- **Continuous Flow Intracorporeal LVAD Pump**
- **Pulsatile Flow Intracorporeal TAH**
- **Pulsatile Flow Intracorporeal LVAD Pump**
- **Pulsatile Flow Paracorporeal LVAD Pump**

**Y-axis:** Implants per year

**X-axis:** Years from 2006 to 2013

**Note:** The figure shows the distribution of implants over the specified period.
Competing Outcomes: Death, transplant & recovery

Implant Dates: June 23, 2006 – March 31, 2011

Proportion of Patients

Months after Device Implant

- Transplant
- Death (before transplant)
- Alive (device still in place)
- Explanted (recovery)

Holman, W. L. (2012). Interagency registry for mechanically assisted circulatory support (INTERMACS): What have we learned and what will we learn? doi:10.1161/CIRCULATIONAHA.112.097816
Device
WHY A LVAD?

- Class IV Heart Failure
- Left Ventricular Failure
- In need of a Heart Transplant or for Destination Therapy
- Heart Mate 2 was FDA approved in 2008 as a bridge to transplant and 2010 as destination therapy.
HEARTMATE II
HMII CONTROLLERS

HMII SYSTEM CONTROLLER

- Test Select Button
- Battery Fuel Gauge
- Yellow or Red Battery Symbol
- Silence Alarm Button
- Power Symbol (Green)
- Driver Cell Symbol (yellow)
- Red Heart Symbol

HMII POCKET CONTROLLER

- Battery Button
- Pump Running Symbol
- Display Button
- User Interface Screen
- Status Symbols
- Silence Alarm Button
COMPONENTS

▪ Power Module
▪ Power Cable
▪ Battery Charger
▪ Batteries and clips
▪ System Monitor (inpatient use)
▪ Display Module (home with the patient)
FORMER HEARTMATE II PATIENT
WHY A HVAD?

- Class IV Heart Failure
- Left Ventricular Failure
- In need of a Heart Transplant
- HeartWare was FDA approved in 2012 as a bridge to transplant and anticipated approval in 2015 as destination therapy.
HEARTWARE
COMPONENTS

HeartWare® Battery Charger and Batteries

HeartWare® Controller AC Adapter

HeartWare® Controller DC Adapter
WHY A TAH?

- Class IV Heart Failure
- BiVentricular Failure, uncontrolled lethal arrhythmias, severe multi-chamber thrombi
- TAH was FDA approved in 2004 as a bridge to transplant and 2012 as destination therapy.
- Freedom Driver was FDA approved in July, 2014.
EXPLODED VIEW OF THE FREEDOM DRIVER SYSTEM
FD PARAMETERS
FREEDOM DRIVER ALARMS

▪ Three Types of Alarms
  ▪ Battery Alarm
  ▪ Temperature Alarm
  ▪ Fault Alarm

▪ Each Alarm indicated by:
  ▪ Visual Alarm and
  ▪ Audible Alarm

▪ Do not ignore Alarms

▪ No way to mute Alarms

▪ The issue that caused the alarm must be immediately addressed
STOP! PATIENT WITH ARTIFICIAL HEART

• FOR EMS PERSONNEL:
  • ABC’S: TREAT AIRWAY AND BREATHING AS USUAL
  • DO NOT FOLLOW ROUTINE ACLS GUIDELINES
  • MUST CHECK FOR PULSE AND BLOOD PRESSURE
  • THE HEART HAS BEEN REMOVED AND THERE IS NO ELECTRICAL RHYTHM
  • DO NOT PERFORM CPR, PACING, DEFIBRILLATION. IT WON’T HELP.
  • THE PATIENT IS 100% DEPENDENT ON THE PUMP FOR BLOOD FLOW.
  • DO NOT GIVEVASOPRESSORS (EPINEPHRINE/VASOPRESSIN) UNLESS DIRECTED.
  • ELEVATED BLOOD PRESSURE CAN CAUSE THE PUMP FAILURE TO WORSEN.
WHAT DOES THE FUTURE HOLD?
YOU READY TO GET TO WORK?
Continuous Flow LVAD/BiVAD Implants: 2008 – 2013, n = 9372

Instantaneous Death Rate (Hazard) for selected causes

- Infection
- Bleeding
- RHF
- Neurological
- Device Malfunction
- MSOF

Deaths/Month vs. Months post implant
RESOURCES

- Patient’s Primary Caregiver
- Implant Center LVAD Coordinator
- Protocols in Select Regions
- Medical Control
- MyLVAD.com
# MECHANICAL CIRCULATORY SUPPORT DEVICES

<table>
<thead>
<tr>
<th></th>
<th>Heart Mate II / Heart Ware (HVAD)</th>
<th>Freedom Driver Total Artificial Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Heart in place</td>
<td>Yes</td>
<td>No – fully mechanical</td>
</tr>
<tr>
<td>Heart rhythm</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Perform EKG</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
| Blood Pressure           | • May or may not have BP using automated or manual cuff.  
                           | • Use Doppler to obtain Doppler BP (similar to MAP but without invasive monitoring)  
                           | • Heart Mate 2 goal 70-90  
                           | • Heart Ware goal 70-85 | Yes  
                           | • Goal: systolic <130 mmHg  
                           | • Pts have protocol for PRN home use of Nitroglycerin SL or hydralazine by mouth at home for elevated SBP |
| Pulse                    | May NOT have a pulse due to continuous flow device | Yes – rate usually 120-130 bpm  
                           | Can view rate on device |
| Sounds                   | Can hear pump hum with stethoscope | Can hear mechanical heart valves click externally |
| CPR                      | Yes - including chest compressions  
                           | May defibrillate/cardiovert with device in place | No |
| Code Drugs               | Yes                               | No – May worsen condition |
| Batteries                | Pair lasts 6-10 hours / Rechargeable | Lasts 4 hours / Rechargeable | Pair lasts 2 hours / Rechargeable |

VAD coordinator 804-828-0951 Pager #4248
DOPPLER BLOOD PRESSURE

- This is not a MAP
- Checked with a manual cuff and doppler
- Normal is 70-90

\[ \text{MAP} = \text{DP} + \frac{1}{3} (\text{SP} - \text{DP}) \]

MAP is the average BP during a single cardiac cycle
MAP > 60 needed to perfuse major organs
<table>
<thead>
<tr>
<th>VAD Related</th>
<th>Non-VAD Related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Failure</td>
<td>Hypovolaemia</td>
</tr>
<tr>
<td>Pump/Cannula Obstruction</td>
<td>Dehydration</td>
</tr>
<tr>
<td>Thrombus</td>
<td>Haemorrhage</td>
</tr>
<tr>
<td>Conduit compression/kinking</td>
<td>Ventricular Dysrhythmias</td>
</tr>
<tr>
<td>Pump Speed set too high</td>
<td>Right Ventricular Failure</td>
</tr>
<tr>
<td></td>
<td>Cardiac Tamponade</td>
</tr>
<tr>
<td></td>
<td>Aortic Valve Regurgitation</td>
</tr>
</tbody>
</table>
LET’S CHECK IT OUT

▪ You arrive at the scene to find a Heart Mate patient with right facial droop, right sided paralysis, slurred speech.

▪ What do we need to do ASAP?
WHAT’S NEXT?

▪ HeartWare patient presents with severe abdominal pain.
▪ Pain started intermittent for several days, but now constant in RLQ.
▪ No nausea or vomiting.
▪ Started her menses.
▪ VAD parameters normal.

What could be wrong?
Holman, W. L. (2012). Interagency registry for mechanically assisted circulatory support (INTERMACS): What have we learned and what will we learn? doi:10.1161/CIRCULATIONAHA.112.097816
▪ Your assessment reveals burgundy urine.

▪ What might this mean?

When do you call the VAD coordinator?
You are transporting a patient to the nearest hospital when…

▪ The patient has a Heart Mate 2 and is not breathing!

▪ What do you do?

ACLS WITH VADS

- Circulation-
  - Pulsatility
  - Perfusion
  - Pump
  - Electrical Problem

- Airway-Typical Management

- Breathing-Typical Management
TRANSPORT CONSIDERATIONS

- Assess for transport needs: typical ALS ground transport, but LVAD patients may be flown by helicopter.

- Where does your patient need to go? Implant center or community hospital?

- Locate and bring backup controller and batteries to the hospital with the patient.

- If not done already, assess for thorough SAMPLE history including the presence or absence of PM/AICDs as well as LVAD—plan for transport of the primary contact or caregiver as well!
TRANSPORT REPORT

- **M-Mechanism of Injury/Nature of Illness:**
  - Summary of event
  - Provide device name in report and known communication with physicians and VAD Coordinators

- **V-Vitals:**
  - Vital signs, Doppler BP if obtainable
  - 12-lead EKG, EtCO2
  - Glucose

- **I-Interventions:**
  - Before and after EMS

- **T-Transport:** Any changes enroute?
  - Provide an accurate time of transport to aid in preparation for the patient.
  - If an extended transport, identify back up transport facilities for loss of airway and circulatory compromise enroute.
Emergency Medical Services Providers

“LVAD’s in the community”

“Today’s challenge for EMS!”

by:
Barbara J Brown, NREMT-P

Emergency Care of LVAD Recipients

EMS Field Guides
- Field Guides Master Document
- HeartMate II
- HeartMate II with Pocket Controller
- HeartWare® Ventricular Assist System
- Thoratec PVAD-LVAD™
- Freedom Driver (Total Artificial Heart)

More on MyLVAD.com
- What is an LVAD?
- LVAD Hospital Locator
- National EMS Week 2012
Questions?

Thank you!
knelson2@vcuhealth.org