Disclosure

No relevant financial relationships by planners or presenters
**Left Ventricular Assist Device-LVAD**

- Surgically implanted mechanical pump that assists the left ventricle for patients with advanced heart failure

- Continuous flow technology, patients will likely **NOT** have a pulse and pulse oximetry may be difficult to obtain
Survival Rates with VADs

Post Implant Survival - Primary LVADs by Era - Intermacs
Primary Prospective Implants: June 23, 2006 to March 31, 2018

Era
- < 2011 (n = 2996, Deaths = 1258)
- 2011-2014 (n = 7981, Deaths = 3170)
- 2015-2018 (n = 7162, Deaths = 1485)

At Risk:
- 7162
- 7981
- 2996

% Percent Survival
0 10 20 30 40 50 60 70 80 90 100

Months After Device Implant
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60

Note: These results reflect unadjusted survival estimates. Observed differences may be due to patient selection, device selection, clinical care and/or other factors.
Shaded areas indicate 70% confidence limits
p (log-rank) = <.0001
Event: Death (censored at transplant or recovery)
Indications for Use

• Bridge to Heart Transplant (BTT)
  • Candidate for cardiac transplantation

• Destination Therapy (DT)
  • Patient does not meet selection criteria for cardiac transplantation
  • Patient will have this device lifelong
Heartmate II
Heartmate II

- FDA approved for BTT and DT
  - Surgical implantation requires an abdominal pocket above the diaphragm
- Powered by two external batteries or small mobile power unit
- Backup battery inside controller
- Pump parameters displayed include speed, flow, PI, and power
- Normal operating speed range 8,400-10,000 RPMs
- Axial Flow
  - More shear stress from propeller blades on blood
  - Causes a mild hemolysis
Heartmate 3
Heartmate 3

• Recently FDA approved for BTT, currently completing DT trial
• Powered by two external batteries or small mobile power unit
• Pump parameters displayed include speed, flow, PI, and power
  • Normal operating speed range 4,700-6,200 RPMs
• Backup battery inside controller
• Built in pulsatility
  • Operates with an artificial pulse, activates every 2 seconds
  • Designed to promote washing of the pump to decrease pump thrombosis
• Centrifugal flow
  • Hemodynamic bearings
  • Less shear stress on RBCs
Heartmate II/3 System Components

- HMII Pocket controller
- HM3 Pocket Controller
- Power Module
- MPU (mobile power unit)
- Battery Charger and Batteries
Heartware

Small pump attaches directly to the heart

Thin, flexible driveline cable exits skin

A small controller & batteries run the pump
Heartware

- FDA approved for BTT and DT
- Display screen with pump parameters
  - Speed, flow, and power (no PI)
  - Normal speed range: 2,400-3,200 RPM
- Powered by two external batteries or AC (wall) power
- Centrifugal flow
  - Rotating element is a spinning disc
  - Less shear stress on RBCs
Heartware System Components

- HeartWare® Controller: Controls and manages VAD operation
- HeartWare® Power Sources: Power the controller and pump
  - Batteries
  - AC adapter (plugs into wall outlet)
  - DC adapter (plugs into car outlet)
- HeartWare® Battery Charger: Can simultaneously charge up to 4 batteries
Pump Parameters

- **Flow**
  - Amount of blood flowing through the VAD
  - Displayed as L/min
  - Calculated value based on speed
  - Fluctuations are normal

- **Speed**
  - How fast the VAD is moving/rotating
  - Displayed by RPMs
  - Fixed speed set by VAD team
  - Heartmate may fluctuate 150 RPMs
  - Heartware should remain fixed

- **Power**
  - Energy required at a given speed
  - Displayed in Watts
  - Fluctuations are normal

- **PI (Pulsatility Index)**
  - Parameter is only displayed on HMII and HM3
  - Indicative of LV filling patterns
  - Calculated value related to the amount of assistance provided by the pump
  - Higher values indicate more ventricular contractility, the pump is providing less support
  - Lower values indicate less ventricular contractility, the pump is providing more support
Alarms

- **Heartware**
  - Will appear on controller display
  - Will have associated ‘yellow’ or ‘red’ display light

- **Heartmate**
  - Will appear on controller display
  - Always make sure the ‘green’ pump running icon is on. If the light is black, that means the pump is off
  - Red alarms are the most serious alarms
Driveline

- Driveline consists of a single cable that extends from the pump through the skin to the controller.
- Driveline contains six wires—three primary wires and three backup wires.
- To prevent infection, the driveline is covered with woven polyester which encourages tissue ingrowth at the skin line. Over time, tissue bonds to the textured material and anchors the external surface of the driveline to the surrounding tissue.
- Heartmate 3 has a modular driveline.
  - A portion of the driveline may be replaced easily by the VAD coordinator/engineer if any damage occurs.
Doppler MAP

• Need to obtain doppler MAP due to continuous blood flow
• You will usually hear 1 number, this is the mean arterial pressure (MAP)
• MAPs should be between 60-80mmHg
• Automated BPs will not always be accurate
  • If you can feel a radial pulse, try obtaining an automated cuff pressure
Long Term Complications

• 1 in 10 patients will experience a stroke
• 2 in 10 patients will develop device related infection.
  • Typically, driveline site infections
  • Caregivers are taught how to complete a daily sterile dressing change
• 2-3 in 10 patients will bleed
  • Patients are typically on a combination of aspirin and coumadin
• 1 % of patients will require a pump replacement either from thrombus or infection
When you are called for a VAD patient, please do the following:

• In most cases, the patient or caregiver has already talked to the VAD team. They should be able to tell you their normal parameters

• If the patient is unconscious, make sure you bring their back-up controller and extra batteries to the hospital

• If VAD is alarming, make sure you check all connections, make sure batteries are charged and connected tightly
Controller Exchange

- If the pump is alarming with a red high priority alarm, the patient or caregiver will have to change to their back up controller.
- If a controller exchange is needed, the patient and caregiver are trained to do so.
- This involves removing the driveline from the controller, which powers the pump.
- This is done in emergency situations only and needs to be done as fast as possible.
- If the controller has been alarming with no power to the pump for an unknown period of time, the patient should NOT change their controller and be taken to the hospital immediately.
  - In this circumstance, we do not know how long the pump has been off. In that time, blood is pooling around the motor of the pump. If it is restarted they are at risk of throwing a clot.
Our VAD team has 24 hour coverage. The patients will know this number and they will have a label on the top of their controller with the VAD pager number: **1-800-206-0552**

- Follow ACLS protocol if needed
- Most of our patients have an AICD
- If patient is having a ‘low flow’ alarm, they may be dehydrated
- Pumps are volume dependent
- Always make sure the patient has their backup controller and two extra batteries with them at all times
- If the situation is not cardiac, treat them like a normal patient
- Our patients are typically overprotective of their pump, they will tell you what to do
VAD Patient Scenarios
58 year old female is stating she is dizzy/lightheaded and has had a ‘low flow’ alarm for the past 15 minutes. She has a Heartmate 3 device. What is the first thing you should assess?

• What are her flows? If the patient is conscious, ask her what her normal flows are.
• Is her pump running icon ‘green’ or ‘black’? This is going to tell you whether or not her pump is working.
• If its black, the pump is off. Ask the patient or caregiver how long the pump has been off. If pump has been off greater than 5 minutes or unknown, do not attempt to restart the pump.
• If the pump is off it may be beneficial to start inotropes (milrinone, or dobutamine)
• If the pump has been off for < 5 minutes, attempt to restart the pump by pressing any of the buttons on the controller. If this does not work, the caregiver is expected to be able to change the controller. Power→patient→power
• If the pump running icon is green, that means her flows are < 2.5 L/min
• Check a MAP
• Assess the need for volume resuscitation
  • How much fluid has she had today?
  • Any signs or symptoms of bleeding?
• The VAD team is always available to help, number located on the patients controller
66 year old male called and stated he fell and hit his head on the bathroom counter. He was instructed to call 911 by the VAD team. What is the first thing you do?

• Neuro exam
• What are his pump parameters?
• Patient and caregiver should know what their normal pump parameters are
• If flows are low, it may be beneficial to give fluids (slowly)
• What is his MAP?
• Transfer to local hospital for stat CT of the head and labs
Caregiver of a 34 year old female called stating that patient had a syncopal episode and is now unconscious. Upon arrival, what should you do?

• Is the patient conscious?
• What is the patient’s rhythm?
• Does the patient have an obtainable MAP?
• What are the patient’s pump parameters?
• If the patient has an unobtainable or critically low MAP (<50) with a life threatening arrhythmia, start ACLS immediately
• Transfer to local hospital.
• If the patient is not located in close proximity to a VAD center, they may need FFL for transfer
References

• Heartware Ventricular Assist Device: Instructions for Use
• Heartmate II Left Ventricular Assist System (LVAS): Instructions for Use
• Heartmate 3 Left Ventricular Assist System (LVAS): Instructions for Use
• ISHLT Website