Modern Left Ventricular Assist Devices (LVAD) : An Intro, Complications, and Emergencies

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An LVAD is a pump that is connected to the left ventricular at, or near the apex and to the ascending aorta. It continuously pumps blood from the left ventricle to the rest of the body.
What are LVADs used for?
- They are used as adjunctive therapy for end stage heart failure.

Are there different types of LVAD Patients?
- At time of implantation, LVAD patients are classified as either:
  
  **Bridge to Transplant:** These patients are currently listed for a heart transplantation, and we have determined they require an LVAD as a “bridge-to-transplant”.

  **Destination Therapy:** These patients do not qualify for heart transplantation at the time of their evaluation. Many patients become eligible for transplantation, and go on to transplantation. Others have medical or social issues that preclude them from transplantation and they will have the LVAD for the rest of their life.
Who qualifies a patient to receive an LVAD?

For Bridge to Transplant Therapy Patients Must:

• Be on the list to receive a heart transplant

For Destination Therapy Patients Must (Per Medicare Guidelines):

• Have chronic end-stage heart failure (NYHA Class IV) who are not candidates for heart transplantation at the time of VAD implant, and meet the following conditions:
  • Have failed to respond to optimal medical management (including beta-blockers and ACE inhibitors if tolerated) for 45 of the last 60 days, or have been balloon pump-dependent for 7 days, or IV inotrope-dependent for 14 days; and,
  • Have a left ventricular ejection fraction (LVEF) < 25%; and,
  • Have demonstrated functional limitation with a peak oxygen consumption of ≤ 14 ml/kg/min unless balloon pump or inotrope dependent or physically unable to perform the test.
**Left Ventricular Assist Device (LVAD)**

- **What are the Contraindications?**
  - Inability to tolerate anticoagulation

- **Other considerations:**
  - Co-morbid conditions
  - Right ventricular function
  - Nonreversible end organ failure
  - Surgical limitations
  - Need for additional cardiac surgical procedures (valve replacement or repair)
  - Acceptance of blood products
  - Pregnancy
  - Social support
  - Financial support
Most of the LVAD is implanted inside the body, except the percutaneous lead that exits the body in the lower abdomen. This lead is used to connect the pump to the system controller and a power source.
Types of LVADs

HeartMate II®
HeartWare®
HeartMate 3®
Axial Flow vs Centrifugal Flow Pumps

- Axial Flow
  - HeartMate II

- Centrifugal Flow
  - HeartMate 3
  - HeartWare
All three of these LVADs follow a few of the same design concepts.

- Rotor/Impeller is the only moving part
  - Increases device longevity
- No Valves
  - Because they do not contain valves, there is a potential for forward and backward flow through the pump
- Flow through the pump increases and decreases based on the native LV
An LVAD is **preload dependent**; that means there needs to be enough blood coming to the LVAD. Therefore, two main factors that affect preload:

- Volume status
- Right ventricular function

The pump is also **affected by afterload**, so any increase in the blood pressure causes the LVAD to consume more power and decreases the LVAD flow and its effectiveness.
The Equipment
HeartMate II/HeartMate 3
System Controller

HeartMate II

HeartMate 3
HeartWare (HVAD)
HeartWare Controller
Potential Complications

- Hypovolemia
- Arrhythmia
- Thromboembolism
- Infection
- Bleeding
- Neurological dysfunction
- Psycho-social issues
- Device Issues
What should I assess when I see LVAD patients?

- Pump function
  - Is the pump running?
  - Pump parameters
- Percutaneous lead connected to system controller and percutaneous lead lock in locked position
- Exit site status, immobilization of percutaneous lead
- Vital signs including mean pressure
- System circulation
- Mental status, level of consciousness
- Weight trend, edema, signs and symptoms of heart failure
- Lab work
Patient Assessment

- Vital Signs
  - No pulse
    Left ventricle does not have enough volume to open aortic valve during systole
  - Blood pressure
    - Cannot use automatic blood pressure machine
    - Doppler used to get mean arterial pressure
    - Target mean pressure of 70-90 mmHg
All LVAD patient’s are anticoagulated due to the risk of clot formation in pump

- Warfarin with goal of 2 to 3
- Aspirin 81 mg daily
- Dipyridamole 75 mg tid for 90 days (HeartMate II only)
- No vitamin K
- FFP
LVAD

- Pump Thrombosis
• No excessive jumping or contact sports
• No swimming
• No exposure to MRI
• Avoid strong static discharge (i.e. TV, computer screens, vacuuming carpets)
• No pregnancy
What happens if the pump stops?

- Most patients have some residual LV function and may maintain an adequate blood pressure. They may quickly develop cardiogenic shock.
  - If minimal LV function, regurgitate flow will cause LV to dilate which is often fatal.
  - Need to restart pump within 10-15 minutes or the pump can not be restarted.
  - Call the LVAD call phone for emergencies.
What would cause the pump to stop?

- Depleted Batteries
- Loss of home power and not switched to battery
- Controller Failure
- Redundant System
  - Driveline Fracture
  - Pump Failure
Emergency Care

Cardiopulmonary Resuscitation

• No CPR
  – This may dislodge inflow or outflow cannula resulting in hemorrhage
• May perform cardioversion or defibrillation as needed. This will not effect the LVAD or controller.
• May give ACLS medications as per ACLS protocol
Emergency Care

Routing of Patients

- Must send patient to Nebraska Medicine or to local ED for stabilization then transfer to Nebraska Medicine
- Other centers will not be able to treat pump related issues
Survival

Post Implant Survival - Primary LVADs
Primary Prospective Implants: June 23, 2006 to March 31, 2016

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<td>90.7% (90.4%-90.9%)</td>
<td>88.3% (85.5%-90.6%)</td>
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<td>6</td>
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<td>85.4% (82.3%-88.0%)</td>
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<td>12</td>
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<td>24</td>
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<td>48</td>
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