**LEFT VENTRICULAR ASSIST DEVICES** by Nick Mark MD & Eric C. Lawson MD

**PRINCIPLE:**
Left ventricular assist devices (LVADs) are semi-permanent hemodynamic support devices implanted in end-stage heart failure. LVADs are surgically implanted intrathoracically or intraabdominally. Several models exist including Heartmate 2/3 (Abbott), HVAD (Medtronic). LVADs can be used as:
- bridge-to-heart transplant (BTT)
- destination therapy (DT, meaning no transplant)
- bridge-to-decision (patient does not qualify for transplant but may in future)

**Indications:** NYHA Class IV for 60-90d, maximal medical therapy, chronic inotrope dependence, and LVEF <25%

**PHYSIOLOGY:**
LVADs consist of an inflow cannula (removes blood from LV), a pump, and an outflow cannula (that returns blood to the aorta). Some LVADs (such as the Heartmate 3 shown) are magnetically levitated centrifugal-flow LVAD. A magnetically levitated contactless rotor enables high flow rates with lower risk of hemolysis or thrombosis. The LVAD functions in parallel with the native heart, unloading LV volume & pressure and reducing LV work. The person with an LVAD wears an external controller unit and battery pack(s). These are connected through the skin via drive line. (When inpatient, LVAD patients typically have an external system monitor & power supply connected). LVADs are preload dependent & afterload sensitive — thus changes in volume status & SVR can dramatically alter CO.

**Pulsatility:** The near continuous flow eliminates pulsatility, so an LVAD patient may be pulseless (this makes Pulse Oximeters unreliable; see pulse oximetry OnePager). Some LVADs (such as Heartmate 3) periodically deceleration & acceleration the rotor by every 2 seconds creating pulsatility.

**MONITORING:**
Return to Flow: Method to assess blood pressure. A manual BP cuff inflated to ~120mmHg. Cuff is slowly deflated with a doppler over brachial artery. Pressure where doppler detects flow is equivalent to MAP. Alternatively an arterial line can be used to measure MAP directly. (see Arterial Line OnePager)

**COMPLICATIONS:**
Suction event occurs when pre-load is inadequate & the LV collapses, transiently stopping flow. Consider transfusion to restore preload.
Stroke: Ischemic & hemorrhagic stroke remain the primary cause of death in LVAD patients at 6-24months. Even w/ gen 2/3 there is 10-1% risk of stroke.
Drive line infection: LVAD specific infection occurring in up to 30% of patients after 3months. Staph is most common. Consider MRSA screening prior to implant with consideration of decolonization.

**Pump Thrombosis**: Turbulent flow intrinsically creates stasis in the pump. Occurs more commonly in 1st generation devices (up to 13%). Newer LVAD pumps have a lower rate of thrombosis. (2nd/3rd gen have ~1% risk) Patients require lifelong anticoagulation.

**Equipment failure:** the driveline, controller, & batteries are also subject to failure. Using external power supply & monitor can troubleshoot.

**Cardiopulmonary Arrest:** Confirm LVAD is not working or adequately perfusing prior to initiating compressions. CPR is OK, but may cause LVAD malfunction.

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**PUMP FLOW:**
Pump flow is a surrogate for cardiac output based on pump speed and power. Typical range is 4-6 L/min.

**PUMP SPEED:**
Pump Speed is the yhe rate of rotation of LVAD rotor. Typical range is 3000-9000 rpm

**PULSE INDEX/PULSATILITY:**
Pulse index (PI) is a dimensionless measure of the magnitude of pulsatile flow generated by the native heart. Typical range is 3-7.

**PUMP POWER:**
Amount of power (W) needed by the LVAD to maintain total output and flow. Typically 4-7W. Rising pump power can suggest incipient thrombosis.