

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


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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)

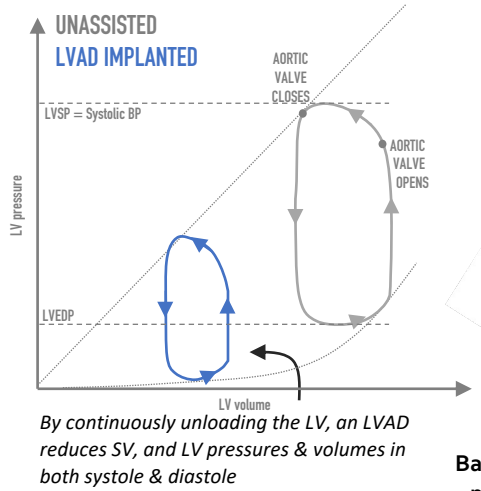
Indications: NYHA Class IV for 60-90d, maximal medical therapy, chronic inotrope dependence, and LVEF <25%.

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](#).



The system monitor indicates **PUMP FLOW**, **PUMP SPEED**, **PULSE INDEX**, and **PUMP POWER**

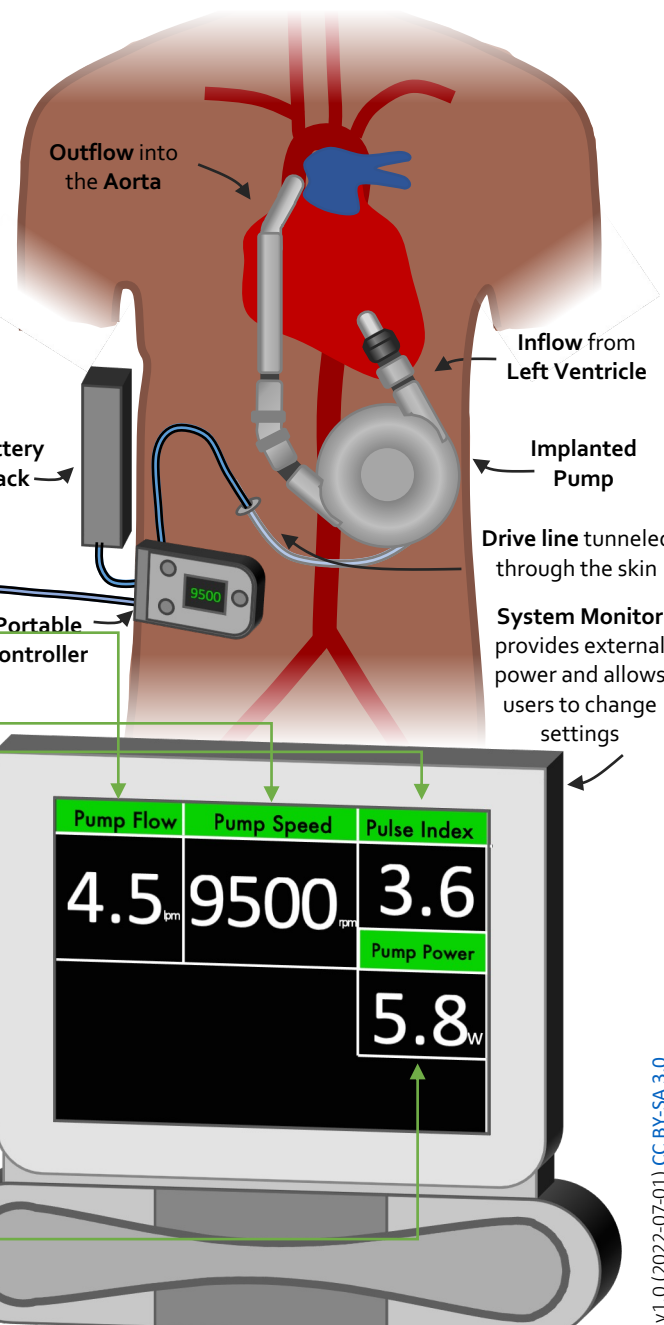
PUMP FLOW:
Pump flow is a surrogate for cardiac output based on pump speed and power. Typical range is 4-6 L/min.

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.

Lower PI= less baseline heart function (consider loss of circulating volume, arrythmia, worsening contractility)
 Higher PI= more baseline heart fxn (inotropes, lower afterload, etc)

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



Pump Flow	Pump Speed	Pulse Index
4.5 _{lmin}	9500 _{rpm}	3.6
		Pump Power
		5.8 _w