PUMP PARAMETER OVERVIEW
There are four parameters monitored on the HeartMate II: Speed, Flow, Power, and Pulsatility Index. No single parameter is a surrogate for monitoring a patient’s clinical status. It is important to consider trends. Each patient’s values are specific to their pump.

**SPEED**
- Speed can only be changed using the system monitor
  - If speed is turned up, more blood is pulled from the LV = ↓ LV chamber size
  - If speed is turned down, less blood is pulled from the LV = ↑ LV chamber size
- The system monitor displays the pump speed in revolutions per minute (rpm). This value matches the actual speed within ±100 rpm under normal conditions

**POWER**
- Device power is a direct measurement of pump motor voltage and current. Changes in pump speed, flow, or physiological demand can affect pump power

**FLOW**
- Flow is an estimate that is derived from a calculation of fixed speed and power
- Flow and power have a linear relationship:
  \[
  \text{↑ Power} = \text{↑ Flow estimate} \quad \text{↓ Power} = \text{↓ Flow estimate}
  \]
  - If the flow estimate falls outside the expected operational range or acceptable linear region, “+++” or “- - -” is displayed. This prevents the display of inaccurate flow information.
  - If flow falls below 2.5 L/min, the device will alarm “low flow”
- Afterload Sensitive: If afterload (blood pressure) is high, the pump will not increase speed to overcome the high outflow pressure. Because power demand is not increased, the displayed flow read out may not change or, potentially, decrease, even though the true flow out of the pump is hindered by the high aortic pressure
- At any given speed, increased blood pressure will decrease flow!

**PULSATILITY INDEX**
- Pulsatility Index (PI) is the left ventricle’s (LV) pulsatile contribution to the pump:
  - LV full → greater stretch → greater contractility = ↑ Pulsatility Index
  - LV empty → less stretch → little contractility = ↓ Pulsatility Index
- PI as it relates to changes in patient’s status:
  - Indicative of changes in volume status due to altered preload
  - Indicative of changes to the natural heart’s contraction
- PI as it relates to changes in pump speed:
  - As pump speed is increased, the PI goes down
  - As pump speed is decreased the PI goes up

**PI EVENT**
- A PI event occurs when there is a 45% + or – change from the previous 15 second running average. Possible causes of events:
  - Suction Event: the inflow cannula is obstructed
  - Dehydration, bleeding, increased diuresis
  - Arrhythmia, Vasovagal response
  - Right heart failure, Increased PA pressure
- If a PI event is detected, the pump speed will automatically reduce to the low speed limit and then gradually ramps back up at 100 rpm/sec to the fixed speed.

LOW “FLOW” ALARMS
1. **Assess** patient – EMERGENTLY (think STEMI page)
   a. Are they bleeding?
   b. What is their blood pressure (mean arterial pressure if no pulse)?
   c. How do they clinically look like?
   d. What are the patient’s last lab results?
2. **Page** the Heart Failure (HF) attending physician
   a. If no response after 10 minutes, page again
   b. If STILL no response, page another HF attending OR the CV surgery fellow on call
   c. You may also page the VAD coordinator (all numbers listed in Web On Call)
3. **Report** the following information to attending, fellow, VAD coordinator (get them ready beforehand)
   a. Your assessment of patient (see above)
   b. The latest LVAD parameters (Flow, Speed, Power, PI or PI amplitudes if HVAD)
   c. Trends of the MAPs and Flows
   d. Urine output
   e. Most recent last lab results
4. You will likely have to **Order** the following, plus any other orders rec’d by the attending...
   a. New set of labs including PT/INR
   b. ECHO to assess RV, LV fxn, inlet cannula obstruction

CARDIAC ARREST IN LVAD PATIENT

**Unresponsive**
- Airway Management per ACLS

**Check VAD**
- Batteries
- Cable Connections
- Monitor/Controller
- + Hum

**Check Pulse**
- Native Spontaneous Circulation Present
- No Hum +

**Check Arterial Flow**
- Deoxygenated Blood
- Flow
- MAP ≤ 50 mmHg

**Check BP**
- Arterial line
- MAP ≤ 50 mmHg

**Confirm No pulse**
- “Unstable Flow”
- + Flow
- Rhythm (shock OK)
- Volume
- Intravenous pressor
- Nominal line
- Reversible causes

**“Flowless Arrest”**
- Med/Int ACLS
- Rhythm (shock OK)
- CPR
- Epinephrine
- Anterolateral
- Anterior line
- Reversible causes

**Re-check Flow & BP ≤ 2 min
**

**Check Flow & BP ≤ 2 min**

**Consider Emergent D.O.R / ECMO**

Refer to page 31 for the SH’s and T’s; to also include Thrombosis of LVAD and emphasize Hypovolemia from GI bleeding

REMINDER!! At any time, please do not hesitate to contact the Cardiology Fellow, VAD Coordinator, or the Heart Failure attending for any questions or concerns on your LVAD patients.