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 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.
  - Look at trends over days (patient daily log)
  - Report trend increases & decreases of 2.0 Watts
  - Report double digit power demands ≥10.0 watts

**FLOW**

- Flow is an estimate that is derived from a calculation of fixed speed and power
- Flow and power have a linear relationship: 
  - ↑Power = ↑Flow estimate
  - ↓Power = ↓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 HM II 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 diuretic dosage
  - 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 100rpm/sec to the fixed speed.
### Clinical Considerations

<table>
<thead>
<tr>
<th>CONT. FLOW PUMP</th>
<th>VITALS</th>
<th>EKG</th>
</tr>
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</table>
| Continuously unloads left ventricle, narrowing pulse pressure | **Blood Pressure**: Manual cuff with a doppler  
- Locate brachial or radial pulse with Doppler  
- Inflate BP cuff. Slowly release at 2mmHg per second  
- First sound heard is “return to flow”. Document this number as the MAP  
- MAP goal: 70 – 90mmHg | **Pump does not affect the EKG** |
| **Pulse**: May be thready or absent | **Oxygen Saturation**: Unable to obtain due to poor capillary bed pulsatility | |

### ACLS/CPR
- **ACLS per protocol**  
- Defibrillation, cardioversion, external pacing okay  
- Do not place pads over the implanted HeartMate II LVAD or implanted ICD  
- Contact implanting center to discuss CPR guidelines

### PUMP ASSMT
- **Assess if pump is running:**  
  - Auscultate over the left upper quadrant to assess if pump is running  
  - Report unusual sounds

### INSPECT EQUIP
- When changing power sources, inspect pins in the connectors of controller power leads, patient cable, and battery clips  
- Any issues with System Controller Operation

### DRIVELINE
- Report any signs of infection including increased WBC or + cultures  
- Sterile dressing change per implant center protocol  
- Ask care provider if concerns with exit site  
- Review frequency of site care  
- Report any tears or separations in the silicone on driveline  
- Ensure patient is using an anchoring system to prevent tugging at exit site

### INR
- **Goal**: 2.0 to 2.5  
- INR goal will vary for each patient. Contact implanting center for patient specific INR goal

### MONITOR REVIEW & DOCUMENTATION
- **Clinical Screen**: Review and Record: Speed, Flow, PI, Power  
- **Settings Screen**: Review and Record: Fixed Speed, Low Speed Limit  
- **Alarms Screen**: Review and Record: Active Alarms  
- **History Screen**: Review Event Log  
- Document the serial number of the system controller in use

### EMERGENCY BAG
- Patient should always carry emergency bag with backup controller, spare batteries and clips, and implanting center contact information

### PATIENT QUESTIONS
- Any concerns with pump function?  
- Changes in how pump feels or sounds?  
- Any alarms?  
- Trauma to driveline site?  
- Concerns with equipment?  
- Decreased battery life?  
- Feelings of heart failure returning?  
- Any bloody stool or nosebleeds?  
- Is urine dark in color?  
- Any weight gain or trouble breathing?  
- Any lightheadedness or dizziness?  
- Any returning symptoms of heart failure?

### DAILY LOG
- Review and assess for trends

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