



STATUS, ALARMS, ACTIONS

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In this lesson, we examine some of the LVAD alarm and warning indicators. And we examine some of the resultant actions you may have to take. As you go through the slides, think about how these concepts may apply to other ventricular assist devices you may encounter.

Various Alarms

- Warning symbols and alarms present on:
  - ✓ Controller
  - ✓ Power module
  - ✓ Charger
  - ✓ Batteries
- Patient may be in trouble due to resolvable mechanical or power disruption
- Get phone numbers of LVAD manufacturer

BATTERY ALARMS



ADVISORY ALARMS



HAZARD ALARM



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Warning Symbols and alarms may be on the controller, power module, charger, and batteries. Your patient may be in trouble due to a quickly resolvable mechanical or power disruption. Again, be sure to get the phone numbers of the LVAD manufacturer, as soon as you can, so you get the timely support you may need.

Battery Alarms

- Symptoms
  - ✓ Defaults to 'Power Saver Mode'
  - ✓ Pump defaults to Fixed Rate Mode of 8000 rpm, or fixed speed setpoint if lower
  - ✓ System will return to set speed once adequate power is restored
- Action
  - ✓ Replace batteries
  - ✓ Or switch to alternate power source

Color	Status/Meaning
Green	Battery is charged and ready for use.
Yellow	Battery is undergoing charge, test, or calibration.
Yellow (Blinking)	Battery requires calibration cycle.
Red	Battery or charging pocket is defective. Do not use battery.



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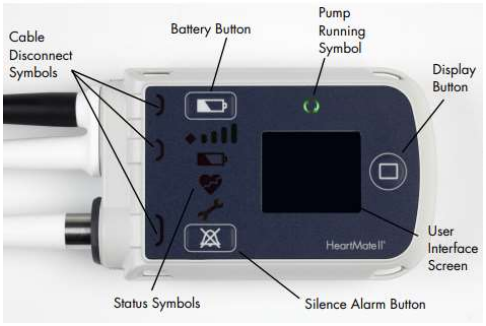
Your initial assessment reveals yellow or red battery indicators. As a result, the unit is in power savings mode, and the pump is operating at minimum speed to preserve the battery. You have some relative straightforward choices.

1. Replace the batteries with charged batteries.
2. Plug the unit into the wall outlet.
3. Switch to the emergency backup unit.

Once the unit is operating in normal mode, you have time to manage as the conditions indicate.

System Controller Cell Low Voltage

- Symptoms
  - ✓ Yellow cell symbol
  - ✓ Beep every 4 seconds
- Action
  - ✓ Replace cell battery and perform System Controller self test



SYSTEM DRIVER CELL LOW VOLTAGE

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Your initial assessment reveals the system controller is beeping every 4 seconds, and the battery indicator has a yellow status.

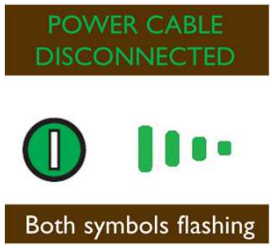
Here, your biggest challenge may be finding 3 AA batteries for the controller. If not sure this is the problem, call the manufacturer.

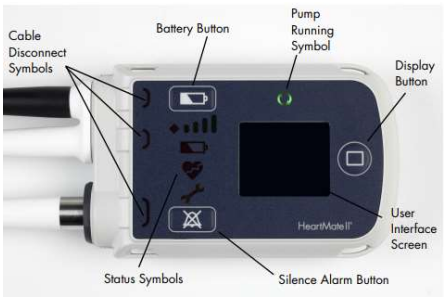
If you can replace the batteries, perform a system controller self-test. The unit will go back into operation if all is well. If not, call the manufacturer or find the backup unit, and install it.

Again, be aware that different models may have different alarm icons, audio notifications, and colors.

Power Cable Disconnected

- Symptoms
  - ✓ Flashing green power symbol & battery power bars
  - ✓ Beep every second
- Action
  - ✓ Check cable connections to power source
  - ✓ Check power leads for damage, replace if necessary





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In this case, your initial assessment reveals the power cable may be disconnected. Some units will beep every second. Others will have symbols showing what is disconnected. Or both.

Well, the unit needs power if the patient is going to survive. Choices are:

1. Check the cable connections to the power source. Fix if obvious.
2. Plug in an alternate power source, batteries or to the wall.
3. Switch to the emergency backup unit.

If not sure this is the problem, call the manufacturer.

Hazard Alarm Low Flow <2.5 LPM

- Symptoms
  - ✓ Pump not operating or not operating correctly
  - ✓ Decreased preload (right heart failure, tamponade, hypovolemia, bleeding, etc.)
  - ✓ Obstruction of pump inflow or outflow
  - ✓ Systemic hypertension
- Action
  - ✓ Assess patient
  - ✓ Monitor

Button Press	Description	Screen Displayed (Example)	Meaning
Press	Press display button ONCE	Pump Speed 9200	Pump speed in revolutions per minute (RPM)
Press	Press display button a SECOND time	Flow 4.6	Pump flow in liters per minute (LPM)
Press	Press display button a THIRD time	PI 4,2	Pulsatility Index (PI)
Press	Press display button a FOURTH time	Power 5.9	Power in watts (W)





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This time, your initial assessment reveals the red heart icon illuminated. It illuminates when the System Controller detects a problem that could cause serious injury or death. This is a Hazard alarm. When the red heart illuminates, check the screen for instructions and take immediate action to resolve the problem.
If the flow is less than 2.5 liters per minute, either the pump or the patient or both have serious problems. Acquire your phone numbers, put ALS on alert and assess as best you can.
Use the controller interface to determine what unit problems may have arisen. Resolve as indicated.
Or, the patient may be experiencing preload. Preload, also known as the left ventricular end-diastolic pressure, is the amount of ventricular stretch at the end of diastole. Think of it as the heart loading up for the next big squeeze of the ventricles during systole. Some people remember this by using an analogy of a balloon – blow air into the balloon and it stretches; the more air you blow in, the greater the stretch. The preload may be a result of right heart failure, tamponade, hypovolemia, bleeding, and other related conditions.
In addition, the flow may be restricted by an obstruction of the pump inflow, or outflow, or possibly Systemic hypertension.
Bottom line, be ready to get assistance from all your available backups.

Driveline Disconnected from Controller

- Symptoms
  - ✓ Nothing is working
  - ✓ Check connections
- Action
  - ✓ Reconnect driveline to controller
  - ✓ Must rotate safety tab to connect or disconnect





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If your assessment turns up a driveline is disconnected. Consider the following:

The driveline connector attaches the driveline to the System Controller. The driveline connector uses a double-lock feature that lowers the risk of accidentally disconnecting the driveline.
The System Controller continually monitors the connection status of the driveline connector. If the System Controller detects a problem, it immediately alarms.
It is impossible to connect or disconnect the driveline without first rotating the safety tab on the back of the System Controller, into the “unlocked” position, as shown in the diagram.
The solution is to reconnect the driveline to the controller.
If reconnecting works, you have time to continue the patient assessment. If not call the manufacturer and for ALS.

STEADY TONE | NO SYMBOL

- Symptoms
  - ✓ No power to pump
- Action
  - ✓ Check system driver connections to pump
  - ✓ Check system driver power connections to power source
  - ✓ Check controller batteries
  - ✓ If persists, seek additional help immediately





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If your assessment reveals a unit with a steady tone and no symbols, and there is no power to the pump, take the following actions:

Check the system driver connections to the pump.
Check the system driver power connections to the power source.
Check the controller batteries.
Locate the backup power and controller and attempt to resolve by replacing one at a time.
If the situation persists, seek additional help immediately.

Overview of Various Manufacturers Alarms

- HeartWare
  - ✓ Will appear on controller display
  - ✓ Will have associated 'yellow' or 'red' display light
- HeartMate II & III
  - ✓ Pocket Controller : will appear on controller display
  - ✓ EPC: no controller display, will have associated 'yellow' or 'red heart' display light
- Red alarms are the most serious alarms



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Here are the controls and displays for the HeartWare, HeartMate II and HeartMate III devices. Take some time to understand the differences. Note that the concepts are the same as we have already discussed. And there will be more on the HeartMate III and HeartWare devices in a following lesson.

So, that's it for this lesson. Be sure to get the manufacturer's phone number and clinical support contact information, as soon as you can, when assessing an LVAD patient.