



UNIVERSITY OF OTTAWA
HEART INSTITUTE
INSTITUT DE CARDIOLOGIE
DE L'UNIVERSITÉ D'OTTAWA

HeartWare and HeartMate3 LVAD Instructions to EMS and Emergency Departments

August 18th, 2021

Left Ventricular Assist Device - Overview

- Left Ventricular Assist Devices (LVAD) are a surgically implanted pump designed to support the left ventricle by augmenting systemic blood flow in patients with end stage heart disease
- Implanted into the apex of the left ventricle with blood entering the pump via the in-flow cannula and directed into the outflow graft which is attached to the ascending aorta
- 3 main reasons for implant:
 1. Bridge to Candidacy
 2. Bridge to Transplant
 3. Destination Therapy (not a transplant candidate)

Left Ventricular Assist Device - Overview

2 types of LVAD's used at the Heart Institute:

1. HeartWare® (no longer being implanted)
2. HeartMate3® (only LVAD being currently implanted)

LVAD are both **PRELOAD** dependent and **AFTERLOAD** sensitive

HeartMate3 – Implanted components

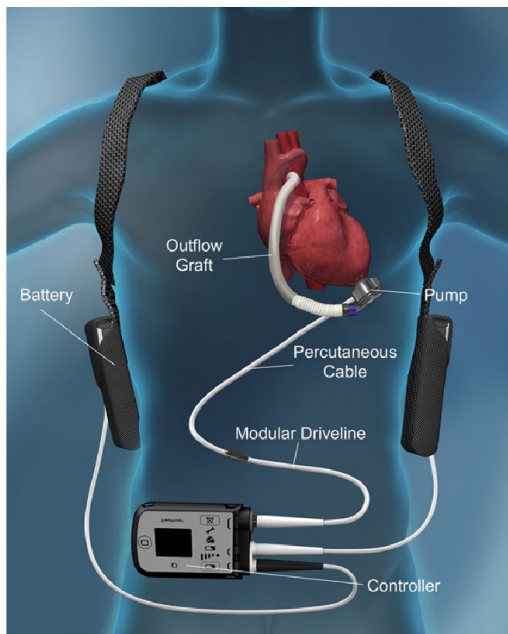
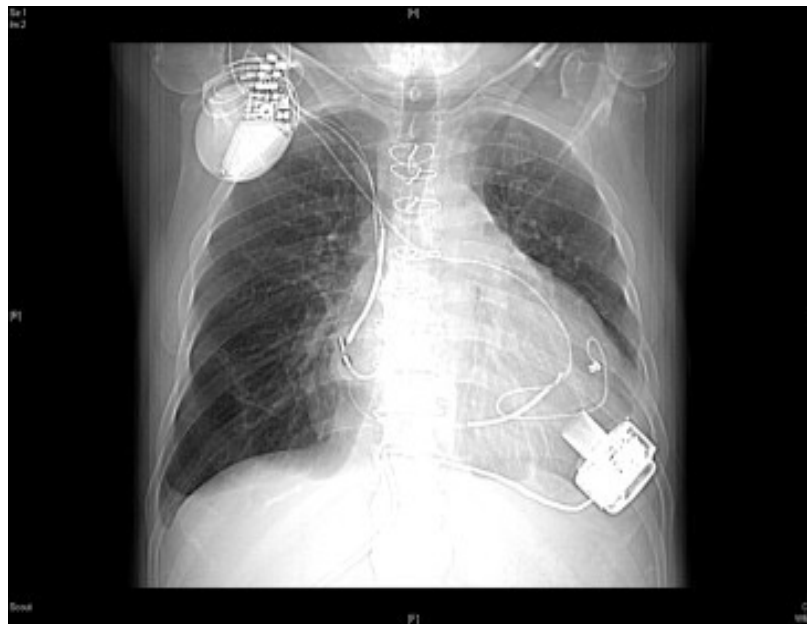


Figure 1: The HeartMate 3 LVAS with the pump in the pericardial space, the



HeartMate3 – External Components

Controller



Lithium-Ion Battery and Battery Clip



Battery Charger



Power Module



HeartWare® – External Components

Controller



Batteries



Battery Charger



A/C Power Adapter



Medical Concerns with LVAD

1. Bleeding: gastrointestinal and other
2. Stroke (ischemic or hemorrhagic)
3. Device infection: driveline
4. Right heart failure
5. Clot formation in the LVAD
6. Trauma/accidents
7. Arrhythmias

LVAD Important Information in the field

- All LVAD are continuous flow devices
 1. No/weak pulse
 2. Difficulty obtaining traditional BP (Doppler MAP)
 3. Difficulty obtaining SpO2 measurements

Blood Pressure Monitoring

- <https://www.mylvad.com/patients-caregivers/lvad-lifestyle/video-library/how-measure-blood-pressure-person-continuous-flow>
- There is often no palpable pulse, due to the continuous flow nature of the device, therefore automated blood pressure devices may not be able to measure accurate blood pressures.
- Mean Arterial Pressure (MAP) directly measured via arterial line or indirectly measured via manual blood pressure cuff and auscultation (the start of Korotkoff sounds is assumed to represent mean arterial pressure) or by Doppler assessment is the primary parameter for monitoring blood pressure
- **Hypertension** may decrease forward flow through the pump, increase the risk of right-sided heart failure and increase the risk of bleeding and/or hemorrhagic stroke.
- **Hypotension** may increase forward flow and increase the risk of a PI event (or suction event), and this may be due to issues with low circulating volume, issues with right sided heart failure, arrhythmias, or inability of blood to flow through the device



LVAD and CPR

Patients are always pulseless

- Look for other indicators of life: breathing, perfusion, MAP
- Is the VAD working? Look for lights on VAD, auscultate their chest for VAD hum. If not working then 1st action should be to get VAD working (ensure adequate power, driveline connected, controller exchange if needed)
- If VAD is working then don't start CPR unless advised by VAD team (page heart failure, VAD coordinator – STAT)
- If you can't get VAD to work and pt condition indicates it then you can do CPR.
- CPR possible, but only if absolutely indicated. There's a chance of dislodging the VAD. Imaging needs to be done after to check position.
- Defib is OK



LVAD Driveline

- External line connecting pump to controller
- Be aware of where the line exits abdomen (covered by a sterile dressing)
- DO NOT DAMAGE/CUT
- HIGH RISK OF INFECTION



LVAD Power

ALWAYS CONNECTED TO A SOURCE OF POWER – if not connected to power the pump will stop

A/C power or batteries (two batteries at a time)

Must always bring extra batteries (as well as charger and base unit if possible)

LVAD Important Information in the field (con't)

- PATIENT IS ANTICOAGULATED
 - Target INR 2-3
 - **DO NOT ADMINISTER VITAMIN K UNLESS DISCUSSED WITH HEART FAILURE STAFF AT UOHI**
- NO MRI
- NO IMMERSION IN WATER (baths, swimming, hot tub)

HOW to ASSESS A PATIENT WITH AN LVAD

- Assess environment
- Assess immediate patient needs
- Assess pump function

1. Listen

2. Look


3. Ask

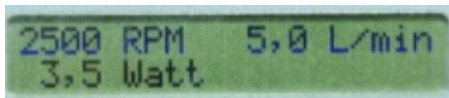
Listen

1. Alarms? Check controller for alarm if alert is heard
2. Auscultate over pump: Humming sound = pump working

Look

Controller Display will give you information










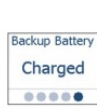


- Pump running symbol  always green when pump running (HeartMate3®)
- Controller Screen will show parameters if running (HeartWare®)
















- The controller will always display active alarms and give most common solution**
- Pump Parameters – Speed, Flow, Power, Pulsatility Index (PI)
- Connections – Power and driveline connected

HeartMate3- Controller: display button- Viewing Pump and System Parameters










Press the Display Button  to view pump parameters and backup battery charge status on the display screen

| Button Press | Description | Screen Displayed (Example) | Meaning |
|---|---|---|---|
|  | Press display button ONCE |  | Pump speed in revolutions per minute (RPM) |
|  | Press display button TWO times |  | Pump flow in liters per minute (LPM) |
|  | Press display button THREE times |  | Pulsatility Index (PI) |
|  | Press display button FOUR times |  | Power in watts (W) |
|  | Press display button FIVE times |  | The System Controller's backup battery (located inside the System Controller and used to temporarily run the pump during a power emergency) has three charge status states: 1. Charged (ready for use). 2. Charging (actively charging). 3. Fault (there is a fault or problem with the backup battery that could affect its reliability). |
|  | Press display button SIX times |  | Blank screen indicates the screen is off, which is normal. |

HeartMate3 Alarm Guide

| Priority | System Controller Screen | Active Symbols | Alarm Means | To Resolve Alarm |
|----------------------------|---|---|---|--|
| H A Z A R D | <div>Call Hospital Contact</div> <div>⓪ :07</div> <div>+</div> <div>Low Flow</div> <div>⓪ :03</div> |  +  | Pump is off. The Pump Running symbol is black. | <ol style="list-style-type: none"> 1. Check if the fixed speed setting is below 4,000 rpm AND the System Controller's backup battery is not installed. Under these conditions, the pump can only be started from the System Monitor's Clinical or Settings screen by pressing the Pump Start button. Otherwise, press any button on the System Controller to attempt pump start. 2. Switch to the backup System Controller and attempt to restart the pump. 3. Clinically evaluate the patient. |
| | <div>Call Hospital Contact</div> <div>⓪ :07</div> <div>+</div> <div>Low Flow</div> <div>⓪ :03</div> |  +  | Low flow, flow is less than 2.5 lpm | <ol style="list-style-type: none"> 1. Ensure that the Driveline is connected to the System Controller. 2. Ensure that a power source is connected to the System Controller. 3. Clinically evaluate the patient. |
| | <div>Connect Driveline</div> <div>⓪ :02</div> |  +  +  | Driveline is disconnected. The Pump Running symbol is black. | <ol style="list-style-type: none"> 1. Immediately reconnect the Driveline to the System Controller and move the Driveline safety lock on the System Controller to the locked position. Also check that the Modular inline connector is secure. 2. If the alarm persists after reconnecting the Driveline, press any button on the System Controller to attempt pump start. 3. If the alarm still persists, check if the fixed speed setting is below 4,000 rpm AND the System Controller's backup battery is not installed. Under these conditions, the pump can only be started from the System Monitor's Clinical or Settings screen by pressing the Pump Start button. 4. If the Driveline is connected and the alarm persists, replace the System Controller with a configured backup System Controller. |
| | <div>Connect Power Immediately</div> <div>⓪ :05</div> <div>+</div> <div>Backup Battery</div> <div>⓪ :01</div> |  +  +  | Both power cables are disconnected. | Immediately connect to a working power source (Power Module, Mobile Power Unit, or two HeartMate® 14 Volt Lithium-Ion batteries). |
| | <div>Call Hospital Contact</div> <div>Controller Fault</div> |  +  | System Controller Hardware Fault (Microcontroller Failure) | No active symbols (constant audio tone). <ol style="list-style-type: none"> 1. Immediately switch to the backup System Controller. 2. Provide the patient with a new System Controller. |
| | <div>Low Battery</div> <div>⓪ :06</div> <div>+</div> <div>Replace Power Immediately</div> <div>⓪ :02</div> |  | Low Battery, Power Input is extremely low with less than 5 min. remaining. | Immediately connect to a working power source (Power Module, Mobile Power Unit, or two fully-charged HeartMate 14 Volt Lithium-Ion batteries). |

HeartMate3 Alarm Guide

| Priority | System Controller Screen | Active Symbols | Alarm Means | To Resolve Alarm |
|--------------------------------------|---|--|--|--|
| A D V I S O R Y | Connect Power ⊖ :04 |  | One of the two power cables is disconnected. | Promptly connect the disconnected power cable to power source (functioning Power Module, Mobile Power Unit, or two fully-charged HeartMate® 14 Volt Lithium-Ion batteries). |
| | Replace Power ⊖ :02 + Low Battery ⊖ :06 |  | Low battery-power input is low, with less than 15 min remaining. | Promptly connect to a working or different power source (Power Module, Mobile Power Unit, or two fully-charged 14 Volt HeartMate Lithium-Ion batteries). |
| | Call Hospital Contact Controller Fault |  | System Controller Hardware Fault | 1. Switch to the backup System Controller. 2. Provide the patient with a new System Controller (with backup battery installed). |
| | Call Hospital Contact Comm Fault |  | Communication Fault (Comm Fault) | Contact Thoratec Corporation to determine best next steps. Use the System Monitor to silence the alarm while awaiting resolution, if needed. Note: The alarm must be active to access the extended alarm silence for this situation. |
| | Call Hospital Contact Backup Battery Fault |  | System Controller Backup Battery Fault | Replace the 11 Volt Lithium-Ion backup battery. Note: If replacing the battery does not resolve the alarm, the System Controller may need to be replaced or additional steps may be required. Call Thoratec Corporation with questions. |
| | Call Hospital Contact Backup Battery Fault +  |  | System Controller Backup Battery Not Installed | 1. Install the 11 Volt Lithium-Ion backup battery in the System Controller. 2. Obtain a new backup battery replacement kit. Note: If replacing the battery does not resolve the alarm, the System Controller may need to be replaced or additional steps may be required. Call Thoratec Corporation with questions. |
| | Call Hospital Contact Driveline Power Fault |  | Driveline Power Fault | Contact Thoratec Corporation to determine best next steps. Use the System Monitor to silence the alarm while awaiting resolution, if needed. Note: The alarm must be active to access the alarm silence for this situation. |
| | Call Hospital Contact Driveline Comm Fault |  | Driveline Communication Fault (Driveline Comm Fault) | Contact Thoratec Corporation to determine best next steps. Use the System Monitor to silence the alarm while awaiting resolution, if needed. Note: The alarm must be active to access the alarm silence for this situation. |

HeartWare® Alarm Guide

| Alarm Type | Alarm Display (Line 1) | Action (Line 2) |
|-----------------------------------|--|---------------------|
| [No Power] Alarm | [no message] | [no message] |
| | When both power sources (2 batteries or 1 battery and an AC adapter or DC adapter) are removed, NO message will display on the controller. The [No Power] alarm will sound but the Alarm Indicator on the controller WILL NOT light. This indicates your pump has stopped. You should immediately connect two power sources. | |
| High – Critical (Flashing Red) | [VAD Stopped] | [Connect Driveline] |
| | [VAD Stopped] | [Change Controller] |
| | [Critical Battery] | [Replace Battery 1] |
| | [Critical Battery] | [Replace Battery 2] |
| | [Controller Failed] | [Change Controller] |
| Medium (Flashing Yellow) | [Controller Fault] | [Call] |
| | [Controller Fault] | [Call: ALARMS OFF] |
| | [High Watts] | [Call] |
| | [Electrical Fault] | [Call] |
| | [Low Flow] | [Call] |
| | [Suction] | [Call] |
| Low (Solid Yellow) | [Low Battery 1] | [Replace Battery 1] |
| | [Low Battery 2] | [Replace Battery 2] |
| | [Power Disconnect] | [Reconnect Power 1] |
| | [Power Disconnect] | [Reconnect Power 2] |

HeartWare® Connections: Power

- Connectors for the power sources were designed to both provide power and to be securely locked once connected to the controller
- Forcing connectors together may damage the pins.
- To prevent damage 1) Grasp the back of the connector, 2) Align solid white arrow and white dot, 3) Gently push (DO NOT twist) until connector naturally locks in place



Power Source
Connector
with Pins



Controller
Connector for
Power Sources



Correct for snap-lock and
audible feedback



Proper hold to connect



Incorrect

Ask

1. Primary caregiver for information and patient diary to compare current pump parameters with historical values
2. Ask caregiver to accompany patient with EMS to hospital – they have been fully LVAD trained

Contact

- Questions or concerns, contact UOHI VAD team:

Office Hours: Monday – Friday 8 a.m. – 4 p.m.

Carita Kerola RN (LVAD Coordinator)

Phone: (613)-696-7000 ext. 14973

Pager: (613)-759-0443

After hours:

Nurse Coordinator

Phone: (613)-696-7000, press 0 and ask to speak to the Nurse Coordinator, please state that it is regarding a LVAD patient

- If unable to reach above, please call: (613) 696-7000, press 0 and ask to be connected to Heart Failure Cardiologist on Call

Additional Resources

MyLVAD is a website that is dedicated to helping the entire LVAD community. Recipients, caregivers, and the Medical Professionals who are involved in their care.

<https://www.mylvad.com/medical-professionals>