

University of Chicago Medical Center

Title: Protocol for Temporary Epicardial/Transvenous Pacemaker Patient Management

Issue Date: May 2021

Revised Date:

Purpose of Protocol: Provide guidelines for care and management of an adult or pediatric patient with a temporary cardiac pacemaker

Background Information: Temporary cardiac pacing (transcutaneous, transvenous, and epicardial) is initiated when a patient's normal cardiac conduction system fails or is at risk of failing to produce adequate electrical rhythm, resulting in hemodynamic compromise.

Protocol Type: Patient Care –Protocol Medical Order required for use.

Department Initiating This Patient Care Protocol: Adult and Pediatric Critical Care Areas, Operating room (OR), Procedural and CCD 4th Floor

Only the following nurses can carry out this Patient Care Protocol: Registered Nurses who have received education and demonstrated competency on the care and management of patients with a temporary cardiac pacemaker and the use of this patient care protocol.

Definitions:

Transvenous pacemaker: Pacing line is placed via the percutaneous route (via an existing or specially inserted one) to the right atrium (RA), right ventricle (RV) or both for pacing. The proximal end of the wire is connected to a pulse generator.

Epicardial transthoracic pacing: electrode wires are attached to the epicardium (RA, RV, or both). Inserted during cardiac surgery in anticipation of conduction defects or arrhythmias. Proximal ends exit through the chest wall for attachment to the pulse generator.

Bipolar electrode systems: Both negative and positive electrode poles are at the distal end of the pacing lead, make small pacing spikes, often not seen on monitors and EKGs.

Capture threshold level: Minimum Pacemaker output in Milliamps needed to capture electrical activity.

Sensing: Ability of pacemaker to detect intrinsic myocardial electrical activity

Pulse generation: Occurs when the pacemaker produces a programmed electrical current for a programmed duration

Failure of pulse generation: the pacemaker does not discharge a pacing stimulus to the myocardium at its programmed time

Failure to sense: The pacemaker either has detected extraneous signals that mimic intrinsic cardiac activity (over sensing) or has not accurately identified intrinsic activity (under sensing)

Failure to capture: The pacemaker has delivered a pacing stimulus that was unable to initiate depolarization and contraction of the myocardium

Inclusion Criteria:

- Adult and Pediatric Patients with temporary transvenous or epicardial pacing leads

Exclusion Criteria:

- Patients with implanted permanent pacemakers
- Patients receiving transcutaneous pacing

Prerequisite Knowledge:

- Knowledge of the normal anatomy and physiology of the cardiovascular system, principles of cardiac conduction, basic and advanced dysrhythmia interpretation.
- Knowledge of temporary pacemaker functions and expected patient responses to pacemaker therapy
- Principles of general electrical safety with the use of temporary invasive pacing methods (gloves should always be worn when handling electrodes to prevent micro shock)
- Knowledge of the pulmonary artery (PA) catheter function and it's use relative to hemodynamic function is a necessity with use of a PA catheter with pacing function (CVICU)

Equipment:

- Pulse generator (pacemaker box)
- Battery/batteries for pulse generator (9 volts or AA)
- Non sterile gloves
- Pacing lead wires
- Pacing lead caps
- Connecting cables
- ECG monitoring equipment
- Dressing supplies
- Central venous catheter insertion supplies

Emergency Equipment:

- Adult or Pediatric Crash Cart

Special Precautions:

- Do not Wedge Pulmonary Artery Catheter while pacemaker wires in place
- Patient cannot go to MRI

Adult and Pediatric Critical Care, Operating room (OR), Procedural, and CCD 4th Floor RN Responsibilities:

Wire Care

- While wires are in place, if dressing is present, dressing is to be changed every 48 hours and PRN. Gloves will be worn during dressing change to protect the wires from hand moisture and the patient from potential electrical hazard.

The dressing (if present) will be labeled with the following:

- Date and time of dressing change
- Nurse's initials
- Wires will be kept separated if more than one wire is present. Exposed end of epicardial lead will be covered with an insulating device. If atrial and ventricular leads are both present, they will be separated and each dressing will be labeled with the type of lead.

Documentation

In WALDO:

- Insertion of epicardial or transvenous wires (LDA in WALDO)
- Name of inserter, time, and location (initial only)
- Number and type of wire(s) present (atrial, ventricular, ground-subcutaneous, bipolar, color of wires)
- Initial assessment, reassessment and prn assessments and interventions
 - Condition of the dressing
- Presence of insulating device/protective cap
- Name of clinician removing wires, time, patient response

In the Cardiac Assessment/Rhythm Flowsheet:

- Ventricular and atrial output in milliamps
- Ventricular and atrial sensitivity threshold in millivolts
- Pacer mode
- Atrial beats per minute
- Ventricle beats per minute
- Temporary wire status
- Battery Change date
- Sensing: Appropriate or Not appropriate
- Capturing: Appropriate or Not appropriate
- Pacing: Appropriate or Not appropriate
- Underlying rhythm
- Initial assessment, reassessment and PRN change in pacemaker settings

Licensed Independent Providers (LIPs) responsibilities:

- Order and Perform Pacer mode, sensitivity, output threshold, A-V interval and heart rate
- Changes to pacemaker settings
- Removal of lead wires

Interpretation, Implementation and Revision:

The Adult and Pediatric Critical Care Committees and the Nursing Leadership of the Critical Care Units are responsible for the implementation, interpretation and revision of this protocol.

References:

Alspach, J. G. (2006). AACN Core Curriculum for Critical Care Nurses (6th ed.). Elsevier

Chiu-Man, C., McGill-Lane, S., Murphy, C., Olen, M., Daley, E., & St. George-Hyslop, C.T. (2016). Care of the patient with a temporary pacemaker in neonatal and pediatric cardiac patients. Sick Children Hospital, Toronto.

Entenmann, A., Niederwanger, C., Cortina, G., Dittrich, S., Hessling, V., & Michel, M. (2018). Standardized training for AVT pacing in pediatric patients with post-operative junctional ectopic tachycardia. *Nursing in Critical Care*, 23(4), 192-197.

Skippen, P., Sanatani, S., Froese, N., & Gow, R.M. (2010). Pacemaker therapy of postoperative arrhythmias after pediatric cardiac surgery. *Pediatric Critical Care Medicine*, 11(1), 133-138.

Wiegand, D.L. (2017). AACN Procedure Manual for High Acuity, Progressive and Critical Care (7th ed). St. Louis Elsevier.

Applicable Elsevier Skills:

Refer to the following skills to guide the care and management of patients with a Temporary Epicardial/Transvenous Pacemaker:

Adult	<ul style="list-style-type: none">• Pacing: Temporary Transvenous and Epicardial Pacemaker Management – CE• UCM Pacing: Temporary Transvenous and Epicardial (Adult)• Pacing: Temporary Transvenous Pacing Lead Removal – CE• Pacing: Epicardial Wire Removal – CE
Pediatrics	<ul style="list-style-type: none">• Pacing: Transvenous and Epicardial Monitoring (Pediatric) – CE• Pacemaker: Assessment of Function (Pediatric) - CE• Pacing: Temporary Epicardial Wire Removal (Pediatric) – CE

Temporary Transvenous and Epicardial Pacing Guide

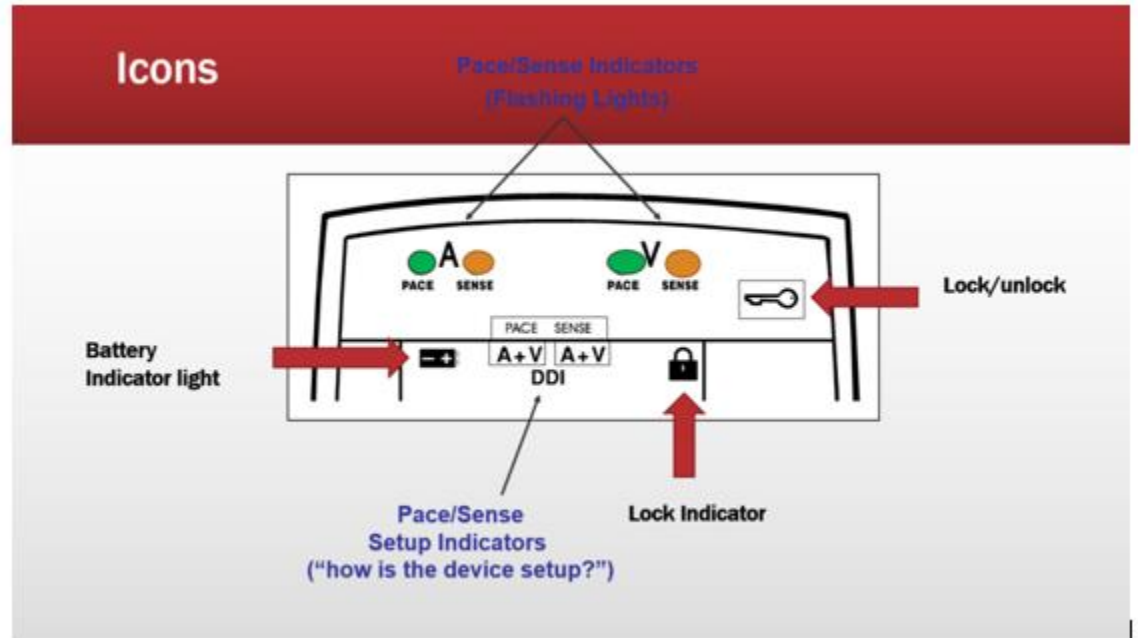
Protocol for Temporary Epicardial/Transvenous Pacemaker Patient Management

- **Station Needs:**
 - Pacer box
 - Wires
 - Syringe
- **Common Indications**
 - Acute MI, Cardiac Surgery, Heart Transplant,
- **Types:**
 - Transvenous (only ICU) - Pacing by a wire that is placed in the right atrium or right ventricle through a central line.
 - Transcutaneous- code situation, pacing through pads placed on the chest and connected to a defibrillator.
 - Epicardial (entire 4th floor) - Pacing by a temporary epicardial wire inserted during surgery directly into the epicardium.
 - Atrial – right of sternum
 - Ventricular- left of sternum
- **Modes:**
 - **Fixed- Asynchronous**
 - Pacemaker is set at a present rate and will fire at that rate regardless of intrinsic activity
 - **Demand:**
 - Pacemaker will only fire when it does not sense heart's own intrinsic activity
- **Pacer box**



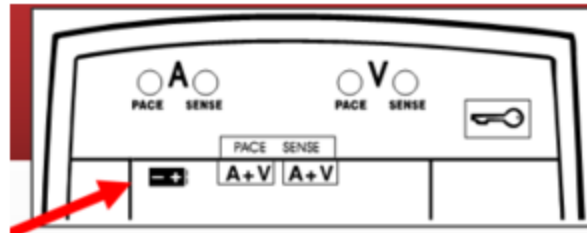
- **Buttons:**
 - **ON:** turn on prior to connecting, preset setting to 80ppm
 - **OFF:** press off button twice within 5 seconds
 - **PAUSE:** typically only done with provider at bedside to check underlying/intrinsic rhythm.

- Display:
 - Rate: 30-200
 - mA
 - Sensitivity
- Icons:



- **Nursing Interventions**

- Back up battery and pacer box at bedside
- Pacer box should be hung on IV pole
- Wire Care
 - Cover exposed end of epicardial lead with insulating device
 - Keep wires separated and label each dressing with the type of lead
 - If dressing present, change every 48 hours and label dressing with date, time, and RN initials.
 - Wear gloves to protect the wires from hand moisture and the patient from electrical hazard.
- Battery Change
 - Requires fresh 9V alkaline or lithium battery
 - Replace battery for each new patient
 - Replace batter when indicator appears and if flashing
 - Device operates adequately for about 24 hours after low batter indicator appears



- Medtronic recommends disconnecting device from patient before replacing the battery
- Pacing is maintained for 15 seconds if device is on while replacing battery
- New batteries will last 7 days guaranteed at 100% pacing, DDD, 70ppm, and 10mA in both the atrium and the ventricle.

- **Documentation**

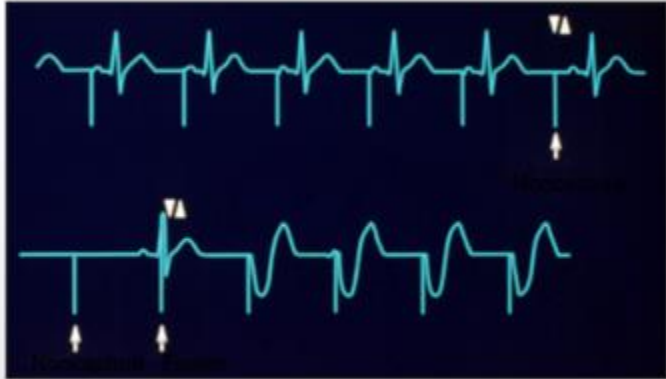
- Prior to coming to you the pacer wires should be entered in WALDO with:
 - Name of inserter, time, and location
 - Type and number of wires present
- Assessment
 - Document setting on initial assessment and with any changes

Pacemaker	
Pacemaker Type	External Pace...
Battery Change Date	3/22/2021
Number of Atrial Wires	2
Number of Ventricular Wires	2
Pacing Wires Status	Capped
Pacing Status	Pacing
Pacer Mode	DDD
Rate Control	
Output in milliamps	
Sensitivity	
Rate Minimum	60
Rate Maximum	100

- Cardiac Assessment/Rhythm Flowsheet

- Ventricular and atrial output in milliamps
 - Ventricular and atrial sensitivity threshold in millivolts
 - Pacer mode
 - Atrial beats per minute
 - Ventricle beats per minute
 - Temporary wire status
 - Battery Change date
 - Sensing: Appropriate or Not appropriate
 - Capturing: Appropriate or Not appropriate
 - Pacing: Appropriate or Not appropriate
 - Underlying rhythm
 - Initial assessment, reassessment and PRN change in pacemaker settings
- - **Troubleshooting:**
 - **Failure to Capture**- Electrical stimuli delivered by the pacemaker does not initiate depolarization of the atria or ventricle

Failure to Capture



- Check connections
- Check settings
- Call Provider

- **Undersensing**- Failure of pacemaker to sense intrinsic R-waves or intrinsic P-waves
- **Oversensing**- Pacemaker over detects small waves (such as P wave), interprets as a QRS complex , and does not send electrical impulse

Failure to Sense/Undersensing



- Check sensitivity setting – may be too high
- Call Provider
- Inappropriate spike can cause lethal ventricular arrhythmias (R on T Phenomenon)

- Pacemaker Nomenclature

Pacemaker Nomenclature

1 st Letter	2 nd Letter	3 rd Letter
Chamber Paced	Chamber Sensed	Response to Sensing
V = Ventricle	V = Ventricle	T= Triggered
A= Atrium	A= Atrium	I= Inhibited (demand)
D= Dual (both A & V)	D= Dual (both A & V)	D= Dual (both triggered and inhibited)
O= None	O= None	O= None (asynchronous)



- Emergency

- Call CV Surgery team
- Activate RRT/Dr. Cart (147)
- **Reconnecting:**
 - Identify and expose A wires and V wires
 - Connect the epicardial wires into the appropriate bridging cable
 - Turn the pacer box on, keep default settings.

-

- **Care after epicardial wires are removed by provider**
 - Observe the patients ECG during wire removal and for at least 24 hour after removal
 - Place a sterile dressing over the exit site
 - Document name of clinician removing wires, time, patient response

- **Pacemaker Workflow**

1. Within one hour of removing the pacemaker from the patient, the nurse should clean the pacer with purple wipes (bleach if cdiff) then bring the pacemaker to their PSC.
2. The PSC should verify that they have one pacemaker available on the unit and then:
 - Place an order with transport to pick up pacemaker(s) and bring them to the CCD 6 OR Command Center
 - In an emergency: Place extra pacemaker in a foam padded tube and send to the CCD 6 OR Command Center tube station (#216)
3. The PSC should then call the CCD 6 OR Command Center @54608 to inform them of the incoming Pacemaker.
4. If the nursing floor requires a Pacemaker, they can call the OR Command Center @54608.



General Information VAD

1. Definition of VAD

- A ventricular assist device (VAD) is an implantable device designed to assist the failing heart, restoring circulation of blood flow to the body through mechanical circulatory support.
- All VADS have 4 components:
 - a) Inflow cannula – takes the blood from the ventricle to the pump
 - b) Pump
 - c) Power Source (Controller and batteries)
 - d) Outflow cannula (takes blood from the pump to the ascending aorta)
- These pumps are valveless, afterload sensitive, preload dependent, follows native pulse and pump output varies over cardiac cycle.

2. ACLS

- OK to defibrillate
- OK to perform CPR

3. Power sources

- Requires power at all times, AC or Batteries
- Change one at a time, never at the same time
- Must have at least one power source connected at all times

4. Back-up equipment:

- Patients must carry extra batteries, a back-up controller, and VAD team emergency contact information whenever they travel outside their home.

5. Vital Signs and Assessment:

- Keep MAP's 65-90 per Doppler
- Patient will be on Coumadin, INR Range 2-3 (unless otherwise stated)
- Patient can ambulated as tolerated with assistance (3x/day)
- Assess for complications:
 - ❖ Bleeding: GIB/melena, stroke, epistaxis, hematuria
 - ❖ Infection = driveline or pump pocket
 - ❖ VAD malfunction (Clot in pump/ lines or PE)
 - ❖ Right heart failure
 - ❖ Arrhythmia V Tach/Vfib
 - ❖ Heart Failure
 - ❖ Stroke/ Neurological dysfunction

6. Document in EPIC Flowsheet:

- RPM's (Speed)
- Flow
- PI (pulsatile Index) – If HM2 or HM3
- Power

7. VAD Driveline site care:

- Sterile dressing changes - Daily and PRN, Drsg Kits are found in Supply Rooms

8. Nursing Care:

- NO MRI
 - ❖ All other imaging is ok if indicated
- Advance diet as tolerated
- Have patient ambulate as tolerated
- Contact sports are contraindicated
- No swimming
- Sponge baths only while inpatient and for first 3 months after implant
 - ❖ May shower once instructed
- May drive w/companion once instructed
- ALWAYS ADMITTED UNDER CARDIAC-THORACIC SUGERY SERVICE.
- **4VAD (4823) Virtual Pager**
- Notify CT RESIDENT ON-CALL AFTER HOURS



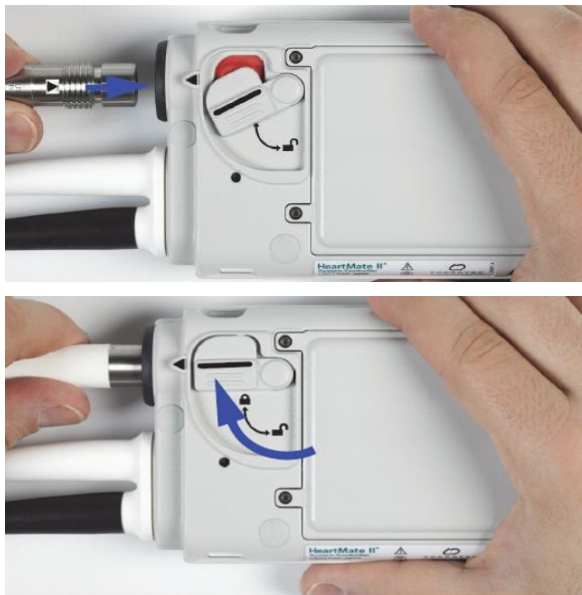
Heartmate II and 3

1. **Components:** Pump, system controller, system monitor, battery pack, Driveline, Battery Charger, Power module and cable
 - a. Modular cable for HM3 only, do NOT disconnect
2. Return batteries to the charger when not in use
 - a. Green lite= battery is charged and ready for use
 - b. Yellow lite= battery is charging
 - c. Red light or no light= the battery is not charged or has a problem contact the VAD coordinator
 - d. Fully charged batteries last 8 hours each
 - e. Takes 4 hours to recharge a fully depleted battery
3. **System Controller Self-Test:** Perform self-test daily. This can be done on battery OR power module. It does not matter.
 - a. Press and hold the battery button for 5 Seconds
 - b. Check that “SELF TEST” appears on the screen
 - c. All symbols and indicators are on the screen, system controller is making a loud steady audio alarm tone.
 - d. Release the battery button after 15 seconds, the screen goes black and the self-test is complete.



- e.
4. **System controller changing the controller:**
 - a. *****Never change the controller without paging 4823, and check the green arrows – if the green arrows are green, do NOT Change the controller because the pump is still on. Only change the controller if the green arrows are BLACK and you do not hear the pump “hum” when you auscultate their chest, indicating the pump is OFF.*****
 - b. Have patient lie down, call for help and stay with the patient
 - c. Get the backup controller
 - d. Unlock the driveline safety tab on the running system controller and backup controller so you can see the red button
 - e. Move the either power source from the running controller to the backup system controller

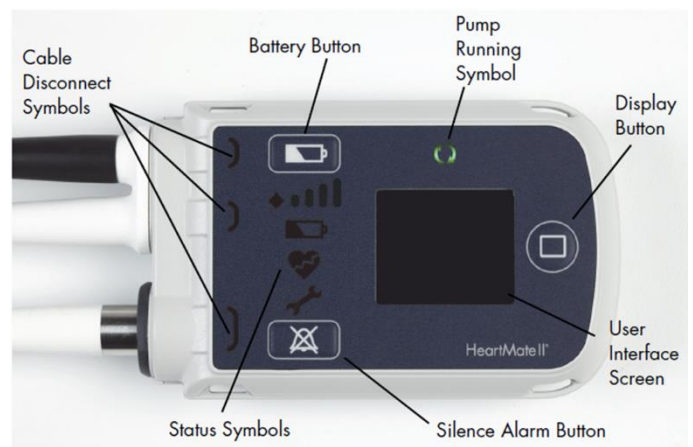
- f. Push red button while pulling the driveline, then to insert the driveline, align the arrow on the controller to the arrow on the driveline cable until they connect and firmly insert the driveline until it snaps into place.
- g. Be sure to slide the safety tab back over the red button, locking the driveline in place.
- h. Tug gently on the metal portion of the driveline to ensure it is fully engaged. If the safety tab does not slide fully over the red button, the driveline is not connected, disconnect and reconnect.
- i. Then move the other power source from the old controller to the backup (“new primary”)
- j. Power down (“sleep mode”) the old controller by pressing and holding the battery button for 5 seconds
- k. Run a self-test on the new controller



PUMP SETTINGS

1. Heartmate II (HM2)

- a. System monitor, Normal values:
 - i. Pump speed- 8,800-10,400
 - ii. Pump flow- 3-6 L/ Min
 - iii. PI- 3-6
 - iv. Power- 3-6 watts
 - v. MAP 65 – 90
 - vi. INR 2-3
 - vii. Low speed limit- 200 – 400 RPM below fixed speed
- b. The pump running symbol is always lit **Green** when the pump is running.
- c. **Red Heart Hazard Alarm:** take immediate action
 - i. Pump off



- ii. Driveline disconnected
- iii. No external power
- iv. Low flow
- v. Low power (<5 min)

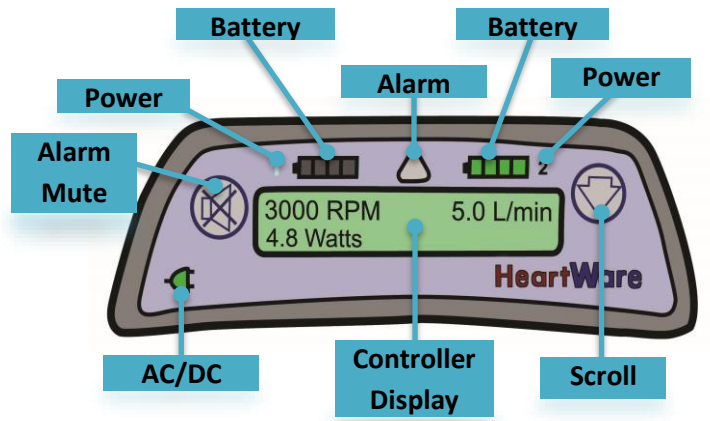
2. Heartmate III (HM3) – ONLY pump we implant at this time

- a. System monitor, Normal values:
 - i. Pump speed 4,700-6,000rpm
 - ii. Pump flow- 3-6 L/ Min
 - iii. PI- 3-6
 - iv. Power- 3-6 watts
 - v. MAP 65 – 90
 - vi. INR 2-3
 - vii. Low speed limit- 100-200 RPM below fixed speed
- b. The pump running symbol is always lit **Green** when the pump is running.
- c. *Modular cable should not be touched. Please call the VAD team if the driveline is damaged.



3. Heartware (HVAD)

- a. System monitor & Settings:
 - i. Speed 2400 – 3200 RPM
 - ii. Flow 3-6 L/min
 - iii. Power 3-6 Watts
 - iv. MAP 65-85
 - v. INR 2-3
 - vi. Waveform on monitor indicates flow and power used during the cardiac cycle.
 - vii. Goal is trough >2L/min and trough to peak (or pulsatility) >2L/min
- b. Battery charger
 - i. Green lite: charged
 - ii. Status: yellow or red – call VAD team.



PAGER-4VAD(4823)

Heartmate 3 (HM3)

Controller



Driveline cable: do NOT touch modular piece!



Battery + clip



Wall power (home)



Wall power (hospital)

Settings

Speed: 4800-6200RPM
Flow: 4-6 L/min
Power: 3-6 watts
PI: 3-6

Heartmate II (HM2)

Controller



Battery + clip



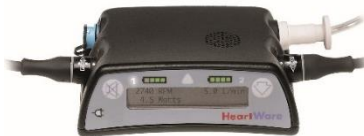
Wall power (hospital)

Settings

Speed: 8800-10200RPM
Flow: 4-6 L/min
Power: 3-6 watts
PI: 3-6

Heartware (HVAD)

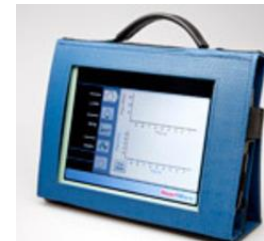
Controller



Battery power



Wall power



System monitor

Settings

Speed: 2400-3200RPM
Flow: 3-6 L/min
Power: 3-6 watts

PAGER-4VAD(4823)



LVAD Dressing Changes

Current Policy:

- Daily dressing changes using the Daily Driveline Dressing Kit (see below) unless instructed and an EPIC order is entered by the VAD coordinator. *Dressing changes may need to be performed more frequently if the driveline site is saturated, leaking, oozing, or not intact.*
- Assess for drainage or signs and symptoms of driveline infection.
- Chlorhexidene Swabstick
- Allow to air dry completely
- Apply dressing
- Apply Centurion Foley anchor to secure driveline (not included in kit)



- Last but not the least, please remember to date, time, and initial the dressing.

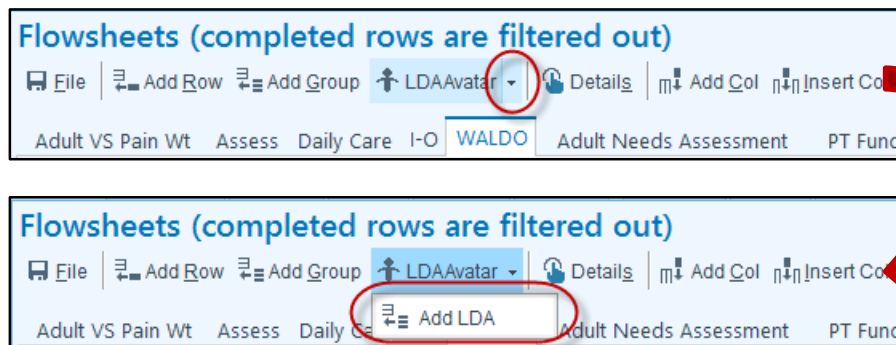
Adding Pacer Wire into WALDO

Summary: this will cover topics Adding Pacer Wires to the WALDO flowsheet, documenting pacer wire status in WALDO, and adding a Pacemaker group to the Assess flowsheet.

Step-by-Step: Adding Pacer Wires to WALDO

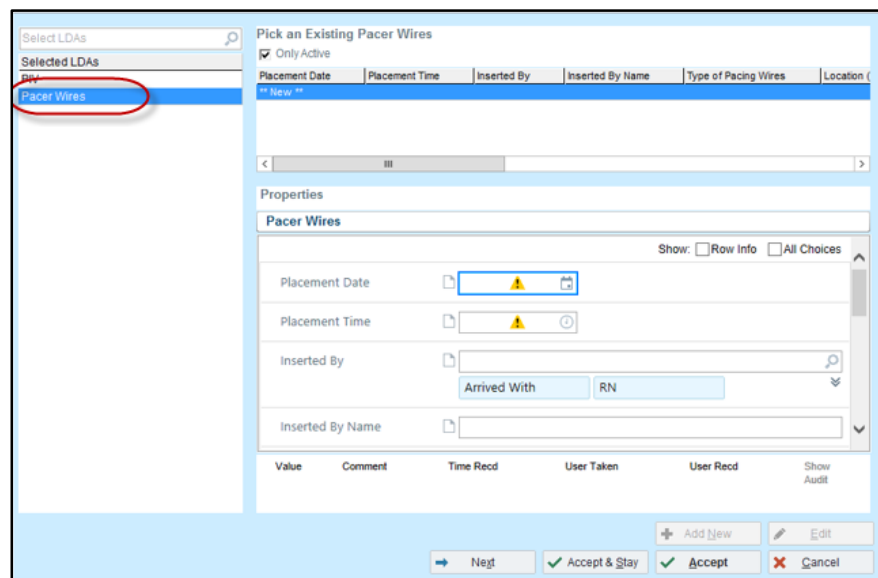
1. Go to WALDO, click small arrow to right of **LDA Avatar**. Select **Add LDA**.

- Separate lines are entered for each atrial and ventricular pacer wire (if 2a and 2v, 4 lines entered)



2. Search and select **Pacer Wires** in the LDA search. Be sure to document the appropriate property rows, and pay special attention to the following:

- Inserters name
- Type of Pacing wires
- Location and color of pacing wires
- Skin prep
- Verification of placement
- Securement



3. Click **Accept** when the form is complete. An individual pacing wire will now be in WALDO.

Adding Pacer Wire into WALDO

Properties

Pacer Wires

Show: Row Info All Choices

#	#1	#2	#3	#4
Placement Date	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Placement Time	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Inserted By	<input type="text"/>			
	Arrived With		RN	
	UCMC Provider		Outside Provider	
	Other			
Inserted By Name	<input type="text"/>			
	Please spell the name (with credentials) of the person who inserted the WALDO.			
Type of Pacing Wires	Unipolar Bipolar Ground			
Location (Pacing Wires)	Atrial Ventricular			
Skin Prep	<input type="text"/>			
	<input type="checkbox"/> Chlorhexidine Gluconate 2%			
	Based on type of line inserted use maximal sterile barrier or aseptic technique (sterile gown, mask, hair cover, large sterile drape) except in emergencies. If not inserted aseptically, changed IV within 24 hours.			
Secured With	<input type="text"/>			
	<input type="checkbox"/> Benzoin	<input type="checkbox"/> Liquid Adhesive	<input type="checkbox"/> Steri Strips	<input type="checkbox"/> Tegaderm
	<input type="checkbox"/> Stabilizer	<input type="checkbox"/> Sutured	<input type="checkbox"/> Transparent Film	<input type="checkbox"/> Tape
	<input type="checkbox"/> Other			
Placement Verification	<input type="checkbox"/> OK to Use ...	<input type="checkbox"/> Blood Gas	<input type="checkbox"/> Fluoroscopy	<input type="checkbox"/> X-Ray
	<input type="checkbox"/> X-Ray	<input type="checkbox"/> Waveform	<input type="checkbox"/> Other	
Removal Date	<input type="text"/>			
Removal Time	<input type="text"/>			
Removed By	<input type="text"/>			
WALDO Reconciliation	<input type="checkbox"/> Not Present on Assessment			

Buttons: Add New, Edit, Accept & Save, Accept, Cancel

Add name of inserter

Inserted By Name

Can use paper icon for additional detail (i.e., color)

Type of Pacing Wires

Location (Pacing Wires)

Skin Prep

Secured With

Tip: Chevron arrow expands options

Used to document removal of wire. Edit properties of existing wire and fill these in

Removal Date

Removal Time

Removed By

Click Accept, and repeat steps 1-3 for each pacer wire

Accept

Adding Pacer Wire into WALDO

Pacer Wire Status Documentation (frequency per unit guidelines)

- The Pacer Wires will now be their own group in WALDO. Document baseline assessment and changes.

Pacer Wires	
Pacer Wire Properties	Placement Date/Ti
Pacer Wire Status	
Site Assessment	Clean
How Pacer Wires are Secured	Atrial wires se...
Dressing Status	Clean
Dressing Intervention	
Dressing Change Due	3/23/2021
Post Removal Complications	None
Interventions	

Step-by-Step: Pacemaker Documentation

- In the **Assess Flowsheet**, open the cascade and select pacemaker. Add **all options**, then click **Accept**.

The following groups/rows are suggested for:

Cardiac (WDP)
Within Defined Parameters (WDP) =
-S1, S2; regular rhythm, rate

Choose groups/rows to add to the flowsheet

Condition: X

Suggested rows

- Pulse Regularity
- Edema Location
- Laterality (Group: CARDIOVASCULAR)
- Edema (Group: Cardiovascular Assessment)
- Monitor Alarm Check
- Monitor Alarms
- High HR Alarm
- Low HR Alarm

Suggested groups

- Capillary Refill
- Cardiac Rhythm Group
- Pulse Quality/Location
- Pacemaker**
 - Pacemaker Type
 - Battery Change Date
 - Number of Atrial Wires
 - Number of Ventricular Wires
 - Pacing Wires Status
 - Pacing Status
 - Pacer Mode
 - Rate Control
 - Output in milliamps
 - Sensitivity
 - Rate Minimum
 - Rate Maximum

Double-click "Pacemaker", or click center Add button

Adding Pacer Wire into WALDO

2. Document each item in the rows:



Pacemaker	
Pacemaker Type	
Battery Change Date	
Number of Atrial Wires	
Number of Ventricular Wires	
Pacing Wires Status	
Pacing Status	
Pacer Mode	
Rate Control	
Output in milliamps	
Sensitivity	
Rate Minimum	
Rate Maximum	

3. Document A and V output/sensitivity in the comment box entry:

Output in milliamps	
Sensitivity	

Click to open comment entry field

4. Document settings on initial assessment and any changes:

Pacemaker	
Pacemaker Type	External Pace...
Battery Change Date	3/22/2021
Number of Atrial Wires	2
Number of Ventricular Wires	2
Pacing Wires Status	Capped
Pacing Status	Pacing
Pacer Mode	DDD
Rate Control	
Output in milliamps	
Sensitivity	
Rate Minimum	60
Rate Maximum	100

Pump Parameter Overview

SPEED Rotations per minute (RPM)

- Speed can only be changed using the Monitor
 - ↑ speed = more blood is pulled from the LV = LV chamber size ↓
 - ↓ speed = less blood is pulled from the LV = LV chamber size ↑
- Pulse Mode (Δ) is ONLY for HM3 = artificial pulse every 2 seconds
- HM2 and HVAD: fixed speed, no pulse, need to program backup controllers to correct speed
- Call if:
 - HM2 or HM3 speed changes $> \pm 150$ RPM
 - HVAD speed changes $> \pm 100$ RPM

POWER Watts (W)

- Power is a direct measure of pump power
 - Changes in pump speed, flow, physiological demand, or pump obstruction (i.e. clot or inflow/outflow kink) can affect it
- Call if:
 - Trend changes $> \pm 2$ watts
 - HVAD **High Watts alarm** should be set to > 9 Watts (**yellow**, medium priority alarm)

FLOW Liters per minute (LPM or L/min)

- Flow is an calculation of speed and power (and Hct % for HM3 and HVAD)
 - ↑ Speed \rightarrow ↑ Flow **AND** ↓ Speed \rightarrow ↓ Flow
 - ↑ Pressure gradient \rightarrow ↓ Flow **AND** ↓ Pressure gradient \rightarrow ↑ Flow
- At any given speed, increased BP will decrease flow
- Call if:
 - Trend changes $> \pm 2$ liters per minute
 - HVAD Low Flow alarm should be set to < 2 L/min (**yellow**, medium priority alarm)
 - HM2/HM3 **Red Heart Alarm** < 2.5 LPM

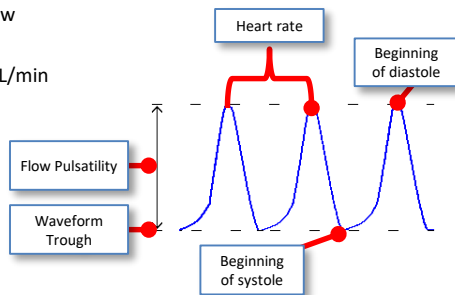
PULSATILITY

Heartmate: PULSATILITY INDEX (PI)

- IMPORTANT:** Heartmate II (axial flow) and Heartmate III (centrifugal flow) PI cannot be interpreted in the same way!!
- Heartmate II:
 - LV Full \rightarrow greater stretch \rightarrow greater contractility = ↑PI
 - LV empty \rightarrow less stretch \rightarrow little contractility = ↓PI
 - PI EVENT $> \pm 45\%$ change in PI from the previous 15 sec average PI
 - With **EVERY** PI event – speed will automatically drop to Low Speed Limit then gradually ramp up
- Heartmate III:
 - Potentially significant if extremely HIGH or LOW, however not a good clinical indicator by itself
 - PI < 2 – potentially related to RV Failure, AI
 - PI > 8 – potentially related to HTN (especially if flows are low)

Heartware: WAVEFORM

- Flow waveform: difference between afterload and preload
- Pulsatility: change in pump flow relative to BP
 - Systole \rightarrow maximum HVAD flow
 - Diastole \rightarrow minimum HVAD flow
- Rule of TWOs:
 - Trough > 2 L/min
 - Pulsatility (trough to peak) > 2 L/min



Clinical Considerations

REMEMBER: One single pump parameter is not a surrogate for monitoring the overall clinical status of the patient!!

PUMP DIFFERENCES:

- HM2:** axial flow, fixed speed, 8,800-10,400rpm
- HM3:** centrifugal flow, pulse mode (Δ), 4,700-6,300rpm
- HVAD:** centrifugal flow, fixed speed – Lavare cycle OFF, 2,400-3,200rpm

VITALS:

- LVAD is continuously unloading the left ventricle, resulting in a *narrow pulse pressure*
- MAP goal: 65-90
 - Manual cuff with doppler (brachial or radial) – first audible sound while deflating cuff pressure is the MAP
 - Automatic cuff pressure: always compare doppler reading to SBP – if the doppler reading is within 10mmHg of the SBP, document the automatic cuff pressure. The doppler is likely the SBP rather than the MAP in this case.
 - Arterial line
- Pulse: can be thready or absent d/t continuous flow
- HR: continuous telemetry for all VADs, call for change rate/rhythm from baseline
- O₂ saturation: might not be able to obtain d/t poor capillary bed pulsatility

WHEN to CALL: S: sepsis/driveline infection D: dehydration/ (over) diuresis

#4823

- | | |
|-------------------------|------------------------|
| H: hemorrhage/hemolysis | O: occlusion |
| A: arrhythmias | R: right heart failure |
| B: bleeding | C: clot |

ACLS/CPR

- OK to: defibrillate, cardiovert, externally pace, perform CPR
- Always check for MAP and auscultate for LVAD hum – if MAP > 60 and pump is running, CPR may not be necessary.

ANTICOAGULATION/ANTIPLATELET THERAPY

- Warfarin (coumadin) + ASA 81mg
- INR goal: 2.0-3.0 unless otherwise indicated

PUMP ASSESSMENT

- Auscultate Left chest for VAD hum
- Report unusual sounds

DRIVELINE

- Daily sterile dressing change (unless ordered otherwise)
- Report any signs of infection: redness, drainage, pain, increased WBC, + cultures
- Report any tears along the driveline
- ALWAYS use a foley anchor to prevent tugging at exit site

EQUIPMENT

- Batteries
 - HVAD: 6-8 hrs per battery, 4 hrs to recharge
 - Connections: [2 batteries] OR [1 battery + AC wall cord]
 - HM2/HM3: 8 hrs per battery (16 hrs for a pair of batteries), 4 hrs to recharge
 - Connections: [2 batteries] OR [AC wall cord]
 - Make sure white to white and black to black when connected to AC wall cord
 - BACKUP BATTERY within the controller – will last 15 minutes if external wall or battery power fails