VENTRICULAR ASSIST/Heart Assist DEVICES
BEST PRACTICES GUIDELINE

Purpose: To provide information and direction regarding the care of patients who have a Ventricular Assist Device (VAD) or a Total Artificial Heart.

Overview of VADs and Heart Assist Devices:
• The VAD assists the native ventricle pumping action and provides the cardiac output needed to survive.
  o These devices are either pulsatile or continuous flow (non-pulsatile).
    ▪ They are further divided into Left Ventricular Assist Devices (LVAD), Right Ventricular Assist Devices (RVAD), or both ventricles (BiVAD).
    ▪ The more common device is a continuous flow pump located in the patient’s thorax attached to the patients’ left ventricle and aorta (LVAD).
  o The assessment of patients with these devices will not be instinctual, as many of the “normal” assessment parameters will not be available or their results will be seemingly contradictory (see Patient Assessment below).
  o A Left Ventricular Assist Device does not preclude the patient from getting right sided heart failure, e.g., Right Ventricular Infarction. Treat per your local protocols.

• The Syncardia Total Artificial Heart includes the actual removal of the heart itself. The device is pulsatile, but there will be no meaningful ECG. NTG is contraindicated in this population. Contact VAD Coordinator for direction on assessing these patients.

Pre-Arrival/On Scene Cues:
• Information regarding the type of device, the implantation hospital, and/or the VAD Coordinator contact telephone number may be available in your Computer Aided Dispatch (CAD) System.
• There may be a tag on the device, on the refrigerator, or on a medical alert bracelet with the name of the device and contact information for the VAD Coordinator at the center that implanted the VAD. This tag or bracelet may be color coded to correspond with the devices listed in Appendix A (Mechanical Circulatory Support Organization EMS Guide, January 2012).
• Assess for presence of a DNR, POLST or Advance Directive.
Initial Assessment

• First **ASSESS THE PATIENT**, not the device.
  
  o The reason for the call may or may not be a problem with the VAD. VAD patients can and frequently do have other medical conditions besides a weak heart.
  
  o Patients with a continuous flow VAD “typically” have no discernible pulse **or blood pressure**.
    
     Because there is no pulse, utilize other parameters for patient assessment (level of consciousness, skin signs, capillary refill, etc.)
    
     Also because of the lack of a palpable pulse, pulse oximetry will be either absent or unreliable.
  
  o Utilize the American Heart Association’s C-A-B recommendations, with one addition:
    
     C = Circulation/Connections (device)
    
     A = Airway
    
     B = Breathing

• Second, assess to see if the device is working.
  
  o If the patient has a continuous flow VAD (non-pulsatile), you will be able to auscultate the left upper quadrant of the patient’s abdomen for the “hum” of the VAD, which can help direct the appropriate actions.
    
     A pulsatile VAD will make an audible sound without auscultation.
      
      * Pulsatile VADs are usually older devices which pump blood via pulsatile mechanism, generating a peripheral pulse.
  
  o Determine if the device has power.
    
     If the device has power it does not necessarily mean that it is working, so the previous step is very important.
    
     If the device has power, you will see a green light on the HeartMate II, the most commonly implanted device
    
     On the HeartWare device, the display will clearly tell you the Liters per Minute (LPM) of blood flow.
    
     If you are unsure what type of device it is, look for the tag (which may be color coded to be in accordance with the VAD EMS Guide – see Appendix A) on the controller, in the patient’s wallet, or on a medical alert bracelet. The patient and/or family/caregiver can also tell you what device the patient has.
  
  o Check the VAD for secure connections and that the batteries are charged and functional.
    
    * **Remain patient-centric. Check the VAD as directed, but remain aware of how your patient is doing clinically. Deliver routine medical care as required.**
- If the pump is pumping then the problem is with the patient, not the device.
- Do ABCs in conjunction with your VAD assessment.

  • Sidestream or mainstream end tidal capnography will read accurately. This will be useful in assessment of these patients.

**Contact/Assistance:**

  - Follow your local protocols or contact your base hospital for orders concerning patient care.
  - If a caregiver is present, utilize his/her knowledge. The patient and their caregiver are the experts on scene for all issues related to the VAD. Listen to their directions regarding VAD device management until you are able to contact the VAD Coordinator.
    - Patients and their caregivers are taught to call 9-1-1 in an emergency and then page the on-call VAD Coordinator immediately.
    - The VAD Coordinator has experience and can help you decide the best course of action.
  - As early in the call as possible, contact the following:
    - Base hospital – The nurse/physician may wish to directly contact the VAD Coordinator to coordinate the care of the patient with them.
    - VAD Coordinator – He/she will talk you through the assessment of the equipment.
      - Check the patient’s wallet card or labels on equipment for information on contact information for the VAD Coordinator.
      - *Only the base hospital is legally allowed to give orders regarding patient care.* The VAD Coordinator can help you to assess the device itself.
    - Receiving hospital – An early “ring down” is critical to help the facility prepare for this highly specialized patient.

**If the VAD is the problem:**

  - If any alarms are going off, or if the device appears not to have power:
    - Reconfirm the connections are secure and that the batteries are charged.
    - Check that the driveline is connected to the controller. Exert great care not to dislodge the driveline.
    - Utilize the caregiver or patient’s knowledge to continue checking the VAD.

**Alarms:**

*Always check and treat your patient first.*

  - Thoratec HeartMate II:
    - Red Heart Alarm
There will be a red heart warning light on the system controller and a steady audio tone.
- Pump flow is less than 2.5 LPM (inadequate to meet the patient’s clinical condition).
- Pump has stopped
- Percutaneous lead (driveline) is disconnected
- Pump is not working properly.

What should you do?
- Check your patient.
- Make sure the system controller is connected to the driveline (also called the percutaneous lead. Handle with great care)
- Make sure the system controller is connected to a power source.
- Treat any sources of low flow or shock (bleeding, hypovolemia, tamponade, etc.)
- Contact the VAD Coordinator, who may direct you to change the system controller to the backup controller.

Low Voltage Alarm (Red Battery Alarm)
- You will hear a continuous alarm.
  - There is less than 5 minutes of battery power remaining
  - Voltage is too low
  - The system controller is not getting enough power from the power module.

What should you do?
- Immediately replace depleted batteries with a new, fully charged pair.
  - ALWAYS change batteries one at a time.
- If batteries are not available, switch to power module, power base unit, or emergency power pack.
  - The controller must be connected to a power source at all times. Batteries or power must be changes one lead at a time to prevent the pump from stopping.
  - Note: Pump speed will gradually decrease to “Power Saver Mode” until the condition is resolved and the alarm clears.

No Power Alarm
- You will hear a steady, audible tone, but will see no lights on the system controller.
  - System controller is not receiving power.
What should you do?
  • Make sure the system controller is connected to 2 batteries or a single power source
    o Batteries
    o Power Module
    o Power Base Unit
    o Emergency Power Pack
  • If alarm continues, switch to a different power source.
  • Contact the VAD Coordinator, who may direct you to change the system controller to the backup controller.

  o Low Voltage Advisory Alarm (Yellow Battery Alarm)
    • You will see a yellow battery warning light and hear an audible tone of one beep every 4 seconds.
    • There is less than 15 minutes of battery power remaining.
    • The voltage is too low
    • The system controller is not getting enough power from the power module or power base unit.

What should you do?
  • Immediately replace depleted batteries with a new, fully charged pair.
    o ALWAYS change batteries one at a time.
  • If batteries are not available, switch to power module, power base unit, or emergency power pack.
    o **At least one battery must be connected at all times.**

  o HeartWare
    o Flashing Red (High – Critical Alarm)
      • VAD stopped, critical battery, or the controller has failed.
      • What should you do?
        • First check your patient and treat as indicated.
        • Connect the driveline, change the controller, or replace battery(ies).
    o Flashing Yellow (Medium Alarm)
      • Controller fault, high watts, electrical fault, low flow, or suction type event.
      • What should you do?
        • Call the VAD Coordinator
    o Solid Yellow (Low Priority Alarm)
      • Low battery, power disconnected
What should you do?

- Replace batteries, one at a time
- Reconnect the power.

If the alarm stops once you have made the adjustment, the equipment problem is solved. Check your patient.

**Patient Assessment Points:**

- Patients with a continuous flow VAD “typically” have **no discernible pulse or blood pressure**.
- Pulse oximetry may not function or it may be inaccurate.
- Automated blood pressure devices are not accurate and manual blood pressures usually cannot be obtained in patients with a continuous flow VAD.
  - A Doppler device can be used to obtain a mean arterial blood pressure (MAP) in these patients. Having a Doppler device is not feasible in the prehospital area. However, the patient’s caregiver may have one and be able to obtain a mean arterial blood pressure.
  - The ideal range for this blood pressure is 70 – 90 mmHg MAP.
- The 12-Lead ECG or heart monitor will show the patient’s native heart rhythm and will not necessarily reflect the patient’s circulatory function.
  - Because of this, the patient may potentially be awake while in ventricular fibrillation. Contact your base hospital for direction. Be able to discuss with the VAD Coordinator, physician, or Base hospital if the patient appears to be stable or unstable in this rhythm.
    - Is the patient short of breath, have delayed capillary refill, poor skin signs, altered level of consciousness?
  - If defibrillation is necessary, consider pre-sedating the patient who is awake. Follow your local EMS protocols and/or base hospital orders.
- The vast majority of these patients will also have an Implanted Cardioverter Defibrillator (ICD) or a Pacemaker/ICD due to underlying ventricular dysrhythmias. Be sure to obtain this crucial data.
- The VAD is preload (filling volume) dependent. Dysrhythmias that would affect preload (e.g. supraventricular tachycardia, atrial fibrillation with rapid ventricular response, ventricular tachycardia, and ventricular fibrillation) need to be treated. VADs pump or work best with adequate patient volume.

**Patient Treatment:**

- All VAD patients should receive the following care:
  - Utilize the American Heart Association’s C-A-B recommendations with one addition:
    - C = Circulation/Connections(device)
    - A = Airway
• B = Breathing
  o Standard airway management
  o Oxygen as clinically indicated
    ▪ Pulse oximetry will not measure or will not be accurate in these patients.
  o IV initiation – prepare for orders for fluid resuscitation (minimum amount initially delivered should be 250 - 500 mls, and then reassess the patient).
  o Standard ACLS except CPR
    ▪ Consult your local EMS protocols or base hospital regarding whether to perform chest compressions or not.
  o Morphine for chest pain management and trauma is appropriate.
  o The use of Nitroglycerin (NTG) can dangerously lower blood pressure and worsen their clinical condition due to the VAD’s dependence upon preload (filling volume).
    ▪ Contact your base hospital for direction regarding the use of NTG.

• Trauma patients:
  o Spinal immobilization and/or splinting may need to be modified to protect the integrity of the VAD equipment. Be careful not to pull or cut the driveline. Make sure all equipment is safely secured.
  o Trauma patients are trauma patients first rather than VAD patients with a trauma. Let the base hospital know that patient has a VAD and may be on anticoagulants.

VAD Complications:
• VAD patients experience a higher percentage of the following conditions:
  o Altered Level of Consciousness/Unconscious and apneic
    ▪ The patient needs to have ACLS instituted immediately per protocol
    ▪ Check airway, institute breathing, then:
      • Immediately check the connections and listen for “hum”
      • Troubleshoot using the VAD EMS Guide, if available.
      • Contact the VAD Coordinator. Be prepared for the VAD Coordinator to give you directions for restarting the pump and possibly changing out the system controller.
      • Medical direction must always come from the base hospital.
  o Hemorrhage
    ▪ Active bleeding/hemorrhage is to be treated following standard protocol and the patient transported to the closest appropriate receiving facility.
 Patients meeting Trauma criteria are to be taken to the closest Trauma Center, and treated as trauma patients according to local protocols.

- **Stroke**
  - Stroke patients need to be transported as usual per local protocol
  - Please note that these patients have a magnet in the device and many times an ICD. They cannot undergo an MRI study, but may undergo a CT scan. Pass this information to the base hospital and to the receiving hospital, if different from the base hospital.

- **Sepsis/Septic Shock**
  - If you feel that these patients have an infection or are in septic shock, they need fluid resuscitation and prompt transportation to the closest most appropriate receiving center.

- **Dysrhythmias**
  - Dysrhythmias need to be managed according to standard ACLS protocols. Where there is conflict, follow the LEMSA’s protocols.
  - If defibrillation or cardioversion becomes necessary, follow the appropriate treatment protocol as there are no contraindications. The pump is insulated and will not be damaged.
    - Most of these patients will have an ICD
    - If defibrillation is necessary, move the controller to the patient’s right side, so it is as far away from the electrical therapy as possible.
    - **DO NOT** disconnect the system controller from the percutaneous lead (driveline) or stop the pump prior to delivering the shock.
    - Dysrhythmias may affect the device and a red heart alarm may sound if the patient is in a low-flow state (less than 2.5 LPM of blood flow, or inadequate to meet the patient’s clinical condition).
    - If the patient has a pulsatile VAD, there will be an external hand pump, which can be used in lieu of performing chest compressions. It can be found in the patient’s equipment. Ask the caregiver. The caregiver has been educated regarding the use of these devices. You may follow the caregiver’s instructions in properly utilizing the equipment. Contact the VAD Coordinator at the implanting center as early in the call as possible for further directions regarding the device.
Transport:

• When transporting these patients to the hospital, the VAD emergency bag, power module, power base unit, batteries, charger, and emergency pack must all be brought to the hospital.
• When possible try to transport the patient to the implanting hospital.
• If transport to the center that implanted the VAD is impossible, transport to the closest VAD Center. If there is no VAD Center nearby, try to transport to a hospital that has cardiac bypass capabilities.
• If the patient is in extremis, or if there is no VAD implantation center or hospital nearby with cardiac bypass capabilities, transport to the closest appropriate prehospital receiving center, per local EMS protocols.
  ○ Patient appears to be in shock (poor skin signs, delayed capillary refill, and/or altered level of consciousness).
  ○ Patient’s ECG shows a dysrhythmia that affects preload (such as ventricular tachycardia, ventricular fibrillation, supraventricular tachycardia, or atrial fibrillation with rapid ventricular response).
• Whenever possible, allow the caregiver to accompany the patient in the ambulance or EMS airship to help facilitate care.

Additional Information:

• The VAD Coordinator may give directions to the EMS provider regarding the VAD equipment.
• Medical direction or destination decisions must be made by the base hospital.
• Remember to always check your patient and treat the patient first rather than the equipment (the VAD or the Total Artificial Heart).

A training PowerPoint has been provided for each provider agency and hospital which further details the care and management of the VAD patient.

There are multiple videos available from Thoratec, one of the device manufacturers, on their website, www.thoratecu.com. There is also an EMS Guide to VADs available on the various devices at www.mylvad.com, or in Appendix A of this document.

Appendix A: Mechanical Circulatory Support Organization EMS Guide, January 2012

Appendix B: Just in Time Training Tool for VADs