Mechanical Circulatory Support Devices

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Acronyms

• **MCS - Mechanical Circulatory Support**
  - Includes VADs and TAHs

• **VAD - Ventricular Assist Device**
  - Further subdivided into RVAD (Right VAD), LVAD (Left VAD), and BiVAD (Biventricular VAD)

• **TAH - Total Artificial Heart**
Objectives

- Understand the indications for VAD and TAH implant
- System overview
- Assessment of patients with a MCS device
- Precautions for patients while on MCS support
- VAD and TAH complications
- Emergency situations
“Running my own business has given me an ulcer, two heart attacks and four nervous breakdowns. I manufacture relaxation tapes.”
Huh?
What is a Ventricular Assist Device?

- A Ventricular Assist Device is a mechanical pump that is implanted into a patient with end-stage heart failure. This pump helps a weakened heart pump blood throughout the body. The VAD does not replace the heart. It assists the heart to pump blood, decreasing the workload of the heart.
What is a VAD and who gets one?

- Heart failure affects 5.1 million Americans
- Bridge to Transplant: Patients who are on the transplant list whose heart will give out before a heart becomes available for transplant.
- Destination Therapy: Long-term management solution for advanced heart failure with a Left Ventricular Assist Device when heart transplant is not an option
What is a VAD and who gets one?

• **Bridge to Recovery**
  - Sometimes used for a few weeks or months to assist the heart during its recovery, e.g., recovery from heart surgery or a heart attack.
HeartWare
But, how does it work?

Blood enters from the left ventricle

Rotor spins at fixed speed

Blood exits/returned to the aorta

HeartWare

Thoratec
HeartMate II
Controller

- Controls rate/Settings
- Connects Pump to controller
- Supplies Power to the Pump
- Provides audio/visual alarms
Components

• Driveline

- This connects the internal pump with the external controller

- The site will be covered with a sterile dressing
Components

• Power Module

• Provides AC Power to System Controller
Components

- Patient Cable
- Connects Power Module to the System Controller
Other equipment you may see

- Back up system controller
- Spare batteries, clips, and power base unit
  - Base unit can simultaneously test and charge up to 6 batteries (8 hours)
Assessment of a VAD patient

• The pump is continuous flow.
  - Patient will be pulseless. This means no pulses, no bp, and no pulse oximetry to assist you in your assessment of them.
  - Caregiver may use a Doppler to obtain a Mean Arterial Pressure.
    • Goal for a Mean BP is 70 - 85 mmHg.
  - Listen in the upper left quadrant for the characteristic “hum” of the VAD. This tells you the device is working.
Assessment of a VAD patient

- **Low BP**
  - Just because you can't get a BP doesn't mean it is low.
  - Is the patient perfusing? If yes, they're probably ok.
  - ETCO2 can help you assess your patient's circulatory function.
Anticoagulation

- VAD patients are typically on Coumadin (warfarin) and aspirin to prevent blood clots
- Patients should not take medications containing ibuprofen
- Monitor for signs of internal bleeding
Basic Care and Treatment

- Standard Airway management
- Oxygen as clinically indicated
- Start an IV and prepare for fluid resuscitation. VADs are preload dependent
- Contact Base Hospital early in the call
  - They will need to contact the VAD Coordinator for direction. *Paramedics in California can only take orders from a Base Hospital, not from a VAD Coordinator.*
Basic Care and Treatment

• Contact Base Hospital early in the call.
  - They can give you medical direction, including destination decisions.
  - Whenever possible, the VAD Implantation Centers would like the patient transported to the hospital that did the implant.
Basic Care and Treatment

• If the pt is unconscious and unresponsive:
  - **C** - circulation and connections
  - **A** - airway
  - **B** - Breathing
    • Really check well for breathing.
Basic Care and Treatment

• There is no contraindication to defibrillation or cardioversion for VAD patients.

• Most VAD patients have an ICD

• Aspirin and nitroglycerin are discouraged

• CT scan is ok, but MRI is not.
Basic Care and Treatment

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Syncardia Total Artificial Heart
The Syncardia TAH includes the actual removal of the heart itself.

The device is pulsatile and driven with compressed air through the Freedom Driver.
- The Freedom Driver is the external driver that powers the artificial heart.

Patients with this device will not have an ECG but will have a pulse.
Total Artificial Heart
Total Artificial Heart
Assessment of a TAH patient

- The device is pulsatile flow, with a loud “galloping” sound coming from the Freedom Driver.
  - Most are set at a rate of 120 - 135 beats per minutes

- ECG will be meaningless, since there are no ventricles.

- TAH patients will not have an ICD.
Precautions

- The MCS’s *must always* have a source of power.
- The driveline *must always* be connected to the system controller (DO NOT CUT!)
  - Only exception: during a malfunction when the controller is changed.
- No trauma to the driveline
- No swimming
- No MRI
TAH and VAD patients (collectively, MCS patients)

• First, assess the patient not the device
  - The reason for the call may or may not be a problem with the MCS device.

• Utilize the AHA C-A-B recommendations with one addition:
  - C = Circulation/ CONNECTIONS
  - A = Airway
  - B = Breathing

• Secondly, assess to see if the device is working.
TAH and VAD patients (collectively, MCS patients)

- Determine if the device has power
  - Look for a tag on the device that tells you what type of device it is.
  - The patient/caregiver can also tell you this.
- Check the MCS for secure connections and that the batteries are charged and functional.
  - If the pump is pumping and no alarms are going off, the problem is with the patient, not the device.
- Do your ABC’s in conjunction with your MCS assessment
What about the caregiver and the VAD Coordinator?

- If a caregiver is present, utilize his/her knowledge. They are the on-scene experts for all issues related to the MCS device.
- Patients and their caregivers are taught to call 9-1-1 in an emergency and then page the on-call VAD Coordinator immediately.
- Not all implanting centers require the patient to have a caregiver.
- **Follow your local protocols or contact your base hospital for orders concerning patient care.**
What about the caregiver and the VAD Coordinator?

• Contact the base hospital as early in the call as possible. If you know the implanting hospital, give the MICN that information.
  - The base hospital should contact the VAD Coordinator immediately and can relay advice to EMS personnel.

• **EMS personnel may only take orders from a base hospital, not from the VAD Coordinator.**
MCS Treatment

• All MCS patients should receive the following treatment:
  - ABC’s
  - Standard airway management
  - Oxygen as clinically indicated
  - IV initiation - prepare for orders for fluid resuscitation
  - In full arrest, consult your base hospital for orders.
A hypertensive crisis in a patient with a TAH (systolic blood pressure >140 mmHg) should be treated with SL NTG. No compressions, cardioversion, external pacing, or defibrillation. Pulse oximetry will measure accurately. Blood pressures are obtainable using a normal sphygmomanometer.
VAD Specific Treatment

- Pulse oximetry will not measure or will not be accurate.
- Riverside County policy #4403 (Ventricular Assist Devices) currently states, “Do not perform chest compressions”. This will be changing in 2016.
- Also from policy #4403: “Do not assist with or give aspirin and/or nitroglycerin”
- You may defibrillate and/or cardiovert
Common Complications - VAD

• **Arrhythmia**
  - Cardiac monitor shows the patient’s native heart rhythm
  - Patients with heart failure are at increased risk for arrhythmia
  - Most VAD patients will have an ICD
  - Patients having arrhythmia problems may be functioning fairly normally.
    - Malignant rhythms still need to be aggressively treated to avoid a “suck-down” event due to decreased preload.
Complications

• Bleeding
  - GI Bleed
  - Hemorrhagic CVA
  - Risk of bleeding is increased because of anticoagulation (aspirin and warfarin)
Complications

• Stroke
  - There may be a clot in the pump that could break off and travel to the brain
  - Frequently hemorrhagic due to the anticoagulation
Complications

• Infection
  - Driveline (also called the percutaneous lead)
  - Pump Pocket
  - Systemic
    • May quickly become septic
    • Usually due to an extensive driveline infection.
Infection prevention

- **Secure the driveline at all times!**
- The driveline is taped with the dressing
- Ensure that the controller is secure
- **Good hand washing!!**
10,000 foot view

• Everything about VAD patients is counter-intuitive
  - They are pulseless, but their perfusion is fine
  - They received the device because they were in end-stage CHF, but the first line treatment is fluids
  - Their ECG can show ventricular fibrillation, but they are talking to you and appear to be mentating normally
  - Their caregiver is an expert in their medical device.
Code Situation - VAD patients

- All orders must come from the base hospital, not the VAD Coordinator.
- Riverside County currently has No Compressions in their VAD protocol. This will change in 2016.
- Advanced airway management as clinically indicated.
- ECG will show the native heart rhythm, which is not necessarily indicative of their perfusion.
**Code Situation - VAD patient**

- Follow LEMSA protocol for:
  - Intubation
  - Medication administration
- Most patients will have an ICD
- External Pacing and defibrillation is okay
  - Don't place paddles over ICD or on batteries or driveline of LVAD
Code Situation - TAH patient

- No compressions - there are no ventricles to compress.
- ECG is meaningless
- Standard airway management
- No defibrillation, external pacing, or cardioversion
- Orders must come from a base hospital, not from the VAD Coordinator
Special Situations

Trauma patient

- These patients are anticoagulated, so watch for bleeding.

- Remember, these are trauma patients who happen to have a VAD or TAH.
  - Treat the trauma. Let the Base Hospital know that the patient has a VAD or TAH, but do not let the VAD/TAH guide the treatment.
Special Situations

- **Acute MI Consideration:**
  - May not have hemodynamic compromise initially with VAD maintaining perfusion.
  - Right ventricular MI can decrease filling of the LVAD, causing pulmonary edema and/or hypotension.
  - TAH patients will not have an MI since there are no ventricles.
Roles

- **VAD Coordinator**
  - Cannot give treatment orders. Contact your Base Hospital and have them communicate with the VAD Coordinator.

- **Base Hospital**
  - Can give treatment and destination orders.

- Ideally, the VAD Coordinator will be coordinating with the Base Hospital to help ensure the best possible care for the patient.
Overview of a MCS patient

- MCS patients are riding their horses, driving on our freeways, going to Disneyland, attending high school graduations.....basically, they are living life to the fullest, and we can expect to find them anywhere. If they do call 9-1-1, it may not be for a problem with the MCS.
California MCS Guideline

• Because of confusion surrounding these patients, a committee was formed in 2011 to develop a statewide guideline for the assessment of VAD patients and delineating the roles of the Base Hospital and the VAD Implantation Center in making destination decisions. This guideline has recently been expanded to include much more on TAH patients. The guideline is available at www.emdac.org.
California MCS Guideline

- Guideline is intended to be a training tool and a resource.
- Championed by EMSAAC and published and endorsed by EMDAC.
- It includes research done by groups on the east coast, including the Mechanical Circulatory Support Organization, which developed a field guide to VADs, available at [www.mlvad.com](http://www.mlvad.com). This guide is updated annually and is color coded by device.
## CA MCS Guideline

### VAD and TAH Differences

<table>
<thead>
<tr>
<th>Ventricular Assist Device</th>
<th>Total Artificial Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually pulseless</td>
<td>Pulsatile</td>
</tr>
<tr>
<td>ECG shows native heart rhythm</td>
<td>ECG is meaningless since there is no heart</td>
</tr>
<tr>
<td>Pulse oximetry is inaccurate or absent</td>
<td>Pulse oximetry is accurate</td>
</tr>
<tr>
<td>Do not use NTG</td>
<td>Patients are ordered to use NTG for systolic blood pressure &gt;140 mmHg</td>
</tr>
<tr>
<td>Consult your local EMS protocols or base hospital regarding whether to perform chest compressions on VAD patient</td>
<td>No compressions on TAH patients</td>
</tr>
<tr>
<td>You may cardiovert or defibrillate</td>
<td>Do NOT cardiovert or defibrillate</td>
</tr>
<tr>
<td>Must auscultate the left upper quadrant of the patient’s abdomen for the “hum” of the VAD</td>
<td>The TAH’s Freedom Driver is audible without a stethoscope, making a “galloping” type of sound</td>
</tr>
<tr>
<td>Usually have an ICD</td>
<td>Do not have an ICD</td>
</tr>
<tr>
<td>May be able to obtain a Mean Arterial Pressure (MAP) using a Doppler device only. Normal sphygmomanometer will not work. MAP should be from 70 – 85 mmHg.</td>
<td>Blood pressure is obtainable utilizing a normal sphygmomanometer.</td>
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</table>
Overview of a MCS patient

• These patients are not sickly old people waiting around to die...
Overview of a MCS patient

• A VAD is a new lease on life for these people
Additional Resources

- [www.thoratecu.com](http://www.thoratecu.com) – Excellent training videos, particularly for EMS
- [www.mylvad.com](http://www.mylvad.com) – Contains an EMS guide to VAD devices, color coded, with instructions for each devices
- [www.syncardia.com](http://www.syncardia.com) and [www.heartware.com](http://www.heartware.com) can give general information about the Heartware and the TAH.
References

2. California EMS MCS Best Practices Guideline
3. www.thoratec.com
4. www.mylvad.com