

Critical Care Medicine Section

The Most Stable Pulseless Patient You'll Ever Meet! A Clinical Update on LVADs in the ED

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The use of left ventricular assist devices (LVADs) has expanded rapidly beyond the initial use as bridge to transplant and bridge to recovery to destination therapy for many patients. While LVADs have significantly expanded quality of life and reduced mortality for many patients with heart failure, they have several significant

unique complications worth watching for in the ED.

Approximately 5.7 million patients in the USA have heart failure, half of those with HF will die within 5 years. Approximately 670,000 new diagnoses of heart failure are made per year. LVAD patients have a presentation rate of 3 per pt LVAD year. As the number of patients with LVAD implants present to the ED it will be increasingly important for physicians to be aware of appropriate standards of care for these patients and what to do/how to troubleshoot in an emergency.

Anatomy of VAD

Modern LVADs are continuous flow devices that function by pulling blood from a weak left ventricle, propelling it to the aorta through a pump placed between the left ventricle and aorta. The pump and circulation connections are all in the body. The pump has a driveline which connects the outside battery packs to the pump. Note that some LVAD drivelines cross the diaphragm, and that location increases the risk of abdominal bacteria causing infection throughout the device. Each LVAD will have a control unit which displays warnings and gives diagnostic information if an error has occurred. The newer versions of LVADs work by using magnet rotors to propel the blood forward. For this reason, MRI is absolutely contraindicated in LVAD patients.

Physical Exam

The most need-to-know physiologic change in the LVAD population is the lack of a reliable pulse, blood pressure reading, and oxygen saturation. Since the great majority of devices generate continuous flow, any pulse or pulse pressure measured is from the native contribution of the patient's cardiac function and should not be deemed reliable of the true pressure.

Basic clinical examination is sensitive for poor perfusion in VAD patients: pallor, capillary refill, and mental status (with frequent rechecks) can establish a baseline, and changes noted from there. In terms of blood pressure, the gold standard in VAD patients should be the doppler mean arterial pressure (MAP). Use the standard blood pressure cuff but instead of using stethoscope (can be used but is less accurate), use doppler to assess the pressure at which flow returns. There is some data to support a MAP of 70 being appropriate in VAD patients, with some patients having lower MAP readings and maintaining adequate perfusion status. Judge perfusion by clinical signs rather than the numbers. Auscultation

of heart sounds will be difficult, however, auscultation can tell you if the pump is working or not, which is a crucial aspect of the patient presentation.

Auscultation should sound like a steady high-pitched motor without clunking sounds. Invasive blood pressure monitoring is a potential option in unstable patients with arterial blood gas for estimation of oxygenation status. ECG will have an abnormal morphology, so compare to baseline for subtle changes. Importantly dysrhythmias such as VT and VF are still easily recognizable, accurate, and a problem. X-rays (AP / Lateral) can indicate gross connection or placement abnormalities. CT scan can indicate more precise dislocations and pockets of infection.

Epidemiology of VAD Issues

The most commonly encountered VAD related complication is bleeding from required anticoagulation. Bleeding requiring transfusion is more common than bleeding requiring operation but up to 70% of VAD patients will encounter this complication. Infection is the second most common complication this statistic encompasses VAD related infection and non-VAD sepsis which alters systemic hemodynamics and VAD flow subsequently. Stroke (ischemic > hemorrhagic) is more common than in non-VAD patients and has higher morbidity. Device related complications

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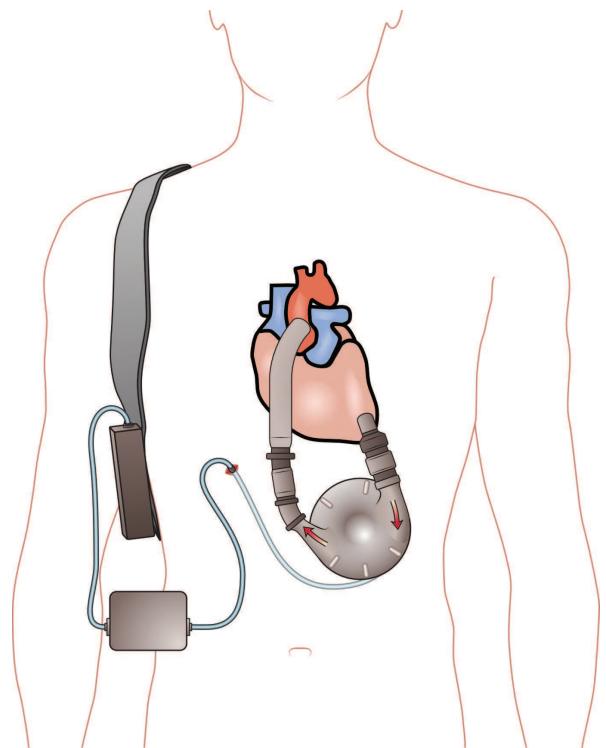


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from intrinsic device failure are uncommon but do occur, with user related device complications being much more common. Pump thrombosis and right heart failure are more uncommon but concerning complications.

Problems

In any VAD related issue contact the LVAD team that follows the patient or contact 24/7 operated advice lines by manufacturer. If the patient presents to a non-LVAD center, stabilization and transfer are the priorities.

Device Problems - Alarm Will Sound

Worst case is the pump is not working. The vast majority of LVAD patients' native heart function will not be able to support their perfusion requirements, especially in states of physiologic stress. A good first pass at solving alarming LVADs is to run the circuit: is the driveline fractured, is it connected to the controller and are the batteries connected and charged? Consider plugging the whole setup into the AC wall outlet if your ED or the patient has the AC adapter.

If the device is off for too long the potential exists for clot formation in the ventricles and device pipelines which is potentially fatal. Restarting the device after a long pause is controversial. Vierecke et al. suggest that if the patient is unstable the pump should be restarted regardless of timeframe, if the pump malfunctioned and can be restarted in minutes it should be considered low risk for clot formation. If the patient is stable with a non-functioning pump, which has been off for a longer period of time (hours) then the patient should be transferred to a VAD center or seen by VAD team before restarting VAD.

Alarm types vary between VAD brands, however as a general rule the more persistent the alarm sound with red lights, the worse the problem and the higher potential for critical failures. These patients will be your 'ABC' patients. Most VADs have yellow warning lights which may indicate a malfunction that is non-emergent but should be evaluated. These will be your 'H&P' patients.

Use the LCD display to guide your differential. Some problems can be fixed easily, while core device faults and dislodgment (both of which are very rare) will require surgery to fix. Some issues such as suction event, high power output, and high RPM are VAD warnings that occur secondary to other systemic pathology such as arrhythmia, RV failure, and device thrombus.

Non-Device Pathology - Alarm May Sound Bleeding

Because VAD patients are anticoagulated, the most common complication is coagulopathy. Many patients present with GI bleeds because of the anticoagulation and an acquired Von Willebrand Factor deficiency from the continuous flow LVAD. Careful consideration should be given to reversing coagulation, and it is an area of great contention. It should be noted that full reversal of anticoagulation represents high risk of device thrombosis or thromboembolism which can be fatal. There is middle ground, some sources recommend giving platelets, Vitamin K, or desmopressin. Talk to the LVAD team before reversing anticoagulation. It is always acceptable to hold further doses of anticoagulation while in the ED. Otherwise treat LVAD patients who have a GIB just like any other GIB patients: serial H&H, type and cross, transfuse to Hgb of 7, and schedule emergent endoscopy.

Infection

Driveline and systemic infection are potentially fatal complications. Treat these patients like your standard sepsis patient, with cultures, broad spectrum antibiotics and source evaluation. Vasopressors are applicable in VAD patients, but remember that VAD patients already operate at low MAPs, hypertension can cause more harm than good but there is limited data, as a general rule MAPs should be between 70 and 80, not exceeding 100.

Stroke: Ischemic / ICH

While ischemic stroke carries a high morbidity and mortality in LVAD patients, hemorrhagic strokes (other than traumatic subarachnoid hemorrhages) are often catastrophic with more than half dying. If an LVAD patient presents with an ischemic stroke, do not push thrombolytics without consulting with the LVAD team. Similarly, if an LVAD patient presents with a hemorrhagic stroke, do not reverse the anticoagulation without consulting the LVAD team. These are controversial areas without strong evidence and approach varies considerably by center, decisions are best made by those with expertise in the field.

Arrhythmia

Tachyarrhythmias are very common in VAD patients. The urgency of intervention can be based upon the clinical presentation of the patients. Unstable patients should be defibrillated like normal. Do not disconnect the controller from the driveline to defibrillate. All currently available LVADs in the US can sustain the shock. Stable patients can be medically managed, even patients in VF/VT. The concern with arrhythmia is a loss of forward flow from the right heart which results in low LVAD flow and suction events.

Hypovolemia

LVAD patients are preload dependent. Dehydration is common, diuretics and nitrates should be used very cautiously. Look for causes of low volume mainly hemorrhage owing to the anticoagulation.

The Coding VAD Patient

In the coding VAD patient, do what you would normally do in an unconscious pulseless patient (pulse in VAD pt is doppler MAP). Call surgery team or device manufacturer or both. Chest compressions have not been shown in one small to increase risk of device malfunction or displacement, though theoretical risk is present and some do not recommend chest compressions. Do not do compressions unless you are sure the patient is not perfusing. There are several reports patients receiving compressions based on no pulses found later to have low MAPs but forward flow with the LVAD. The bailout for a dying LVAD patient is venous-arterial ECMO. Defibrillation is applicable and useful as some arrhythmias will decrease flow through the heart and increase risk of thrombosis.

Conclusions

As LVADs become more common, the chances of seeing one in the ED near you will increase. The devices are complex and require a team of surgeons and critical care specialists to manage these patients. When unsure it is never wrong to contact the patients LVAD center or

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manufacturer as they can provide greater insight into the potential problems that can occur with the devices. ●

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