ORIGINAL RESEARCH

Emergency Medical Services Protocols for Assessment and Treatment of Patients with Ventricular Assist Devices

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Abbreviations:
EMS: Emergency Medical Services
EMT: emergency medical technician
LVAD: left ventricular assist device
MAP: mean arterial pressure
VAD: ventricular assist device

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Abstract

Background: Patients with ventricular assist devices (VADs) represent a growing population presenting to Emergency Medical Services (EMS), but little is known about their prehospital care. This study aimed to characterize current EMS protocols in the United States for patients with VADs.

Methods: States with state-wide EMS protocols were included. Protocols were obtained from the state EMS website. If not available, the office of the state medical director was contacted. For each state, protocols were analyzed for patient and VAD assessment and treatment variables.

Results: Of 32 states with state-wide EMS protocols, 21 had VAD-specific protocols. With 17 (81%) states noting a pulse may not be palpable, protocols recommended assessing alternate measures of perfusion and mean arterial pressure (MAP; 15 [71%]). Assessment of VAD was advised through listening for pump hum (20 [95%]) and alarms (20 [95%]) and checking the power supply (15 [71%]). For treatment, EMS prehospital consultation was required to begin chest compression in three (14%) states, and mechanical (device) chest compressions were not permitted in two (10%) states. Contact information for VAD coordinator was listed in a minority of five (24%) states. Transport of VAD equipment/backup bag was advised in 18 (86%) states.

Discussion: This national analysis of EMS protocols found VAD-specific EMS protocols are not universally adopted in the United States and are variable when implemented, highlighting a need for VAD teams to partner with EMS agencies to inform standardized protocols that optimize these patients' care.

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Introduction

Ventricular assist devices (VADs) are being used with increasing frequency to support heart function in patients with heart failure, making patients with VADs an important and growing population for Emergency Medical Services (EMS) providers. The use of left ventricular assist devices (LVADs), the most common VAD, increased 12.6% annually from 2009 to 2014.[1] Further, the continued technological development of VADs is associated with increased safety and durability.[2] Finally, VADs can function as a bridge to transplant or as a destination therapy for those ineligible for transplant. Patients with VADs as a destination therapy may use a VAD for years rather than the weeks or months seen in bridge to transplant VADs.[3,4] Together, the increasing use, safety, and duration of VADs mean EMS providers can expect to treat an increasing population of patients with VADs.

Reports of patients with VADs in the emergency room highlight VAD-related complications, but prehospital evidence is limited. From 2010-2018, the United States had 57,200 emergency room encounters for adult patients with LVADs.[5] Complications related to VADs, such as infection or right ventricular failure, were common and associated with increased risk of admission in pediatric and young adult populations.[6,7] These findings have shaped guidelines in emergency medicine, focusing on early recognition of VAD complications and early involvement of and communication with the VAD team.[8,9]

While characterizations of emergency room presentation of VAD patients exist, prehospital literature is much more limited. Specifically, only two prehospital reports of VAD patients were identified. The first, by Schweiger, et al, is a case report of two VAD patients requiring EMS, one with a system malfunction and the second for an unconscious patient.[10] The second report, by Goebel, et al, was a case series of 16 patients with VADs requiring EMS, finding weakness and chest pain to be the most common complaint, with complaints often not VAD-associated.[11]

The care of patients with heart failure is complex and requires a coordinated team approach. Heart failure teams in the hospital optimize care of patients at nearly every point, but the prehospital management of these patients remains an opportunity for growth.[12] The current status of state-level prehospital VAD recommendations in the United States is unknown. Previous studies have provided insight on national EMS protocol content and heterogeneity.[13] Given the increasing prevalence and high acuity described for this patient population, the aim of this study is to characterize EMS protocols for patients with VADs through a nation-wide analysis of EMS protocols.

Methods

States with state-wide EMS protocols were included. All EMS treatment protocols were acquired through conducting an online search in January 2023. State EMS system websites in all 50 states and Washington, DC were first queried, and the state EMS medical director was contacted for further inquiry if protocols were not available online. States with local or regional EMS protocols were excluded. The most recent versions of the state-wide EMS protocols were compared between states. Two reviewers, JW and SM, independently assessed VAD sections of the protocols, including patient, VAD function, and treatment variables. For discrepancies between reviewers, the final tie-breaking decision was made by EL. Outcomes were also compared between states with and without high-volume VAD centers (defined as states with a Centers for Medicare and Medicaid Services [CMS; Baltimore, Maryland USA] Destination Therapy Center), but no significant differences were found.

Results

Of the 50 states and Washington, DC, 32 (63%) had state-wide EMS protocols accessible to the public online. Of these, 21 (66%) provided guidance on the management of patients with VADs. Figure 1 illustrates states with published state-wide EMS protocols and presence of VAD-specific direction.

All states with VAD protocols provided specific direction on patient assessment (Table 1). To assess perfusion, 16 (76%) states listed mental status, 15 (71%) states listed skin color, four states (19%) listed skin temperature, and seven states (33%) listed capillary refill for patients with VADs. With 17 (81%) states noting that a pulse may not be palpable, protocols advised using mean arterial pressure (MAP) in 15 (71%) states and listed an appropriate range in seven (33%) states. Finally, to assess VAD function, 20 (95%) state protocols advised listening for hums, 20 (95%) for alarms, and 15 (71%) said to check the power/batteries of the VAD.

Treatment protocols for VAD patients are listed in Table 2. Logistics of VADs were frequently addressed. The VAD coordinator contact information was provided in five (24%) state protocols, with varying indications for when to contact the VAD coordinator. While almost all (18 [86%]) states advised the transport of VAD materials and backup bag, a minority (5 [24%]) detailed to change batteries one at a time (if indicated). Eighteen (86%) state protocols listed specific indications to perform chest compressions, and two (10%) advised mechanical chest compressions should not be performed on patients with VADs. Other treatment protocols for patients with VADs included placing defibrillation pads anterior-posterior (Pennsylvania), defibrillating ventricular tachycardia or fibrillation only if symptomatic (Alabama), and prohibiting administration of nitroglycerin (Arizona).

Discussion

In this review of United States EMS protocols, it was found that the majority (21 [66%]) of states with protocols available provided specific guidance for assessment and/or treatment of patients with VADs. Included VAD-specific instructions for assessment were MAP, alternate methods of assessing perfusion, and VAD function; and VAD-specific instructions for treatment addressed contacting VAD coordinators, transporting VAD supplies, and chest compressions. However, protocols were inconsistent by state and had varying guidelines.

The variability in EMS protocols observed in this study is consistent with prior studies characterizing heterogeneity of EMS protocols by state. Multiple other high-acuity conditions, including stroke, traumatic brain injury, and traumatic cardiac arrest, have been shown to have inconsistent EMS protocols throughout the United States.[14–16] In this study, it was found that specific guidance for the assessment and treatment of VAD patients in EMS ranged from 10%-95% agreement, reflecting a high level of state-to-state heterogeneity. Though this variability is concerning on a broad scale,[17,18] it is especially concerning with regard to patients with VADs given their high level of medical complexity.

Multiple sources provide guidance on prehospital care for patients with VADs,[19–21] but a review by the American Heart Association (AHA; Dallas, Texas USA) provides specific and in-depth EMS guidance for the care of patients with VADs.[22] They recommend assessing perfusion and VAD function, note that a pulse may not be present, and suggest calculating MAP, as found in many of the state VAD protocols in this study. Point-of-care echocardiography and Doppler, if available, were also advised to assess VAD function and blood flow, respectively, though these are unlikely to be accessible prehospitally. Chest compressions were indicated for patients with signs of poor perfusions with a MAP <50 or lack of VAD function. Of note, these guidelines did not advise against the use of mechanical chest compressions for patients with VADs, as seen in two of the state protocols in this study. While there have been reports of increased injury in recipients of mechanical versus manual chest compressions,[23] outcomes of VAD dislodgement and injury have not specifically been explored. Malfunction of VADs was also addressed, with the guidelines advising change out of the system controller may be considered for VAD malfunction without an alternative explanation, an option not provided in any of the state protocols. Finally, these guidelines discussed the important interface of VAD providers and EMS providers but highlighted an important issue: EMS providers are required to receive direction exclusively from medical control directors, who are typically not VAD-trained. Therefore, while the majority of states in this study provided contact information for VAD programs, this contact may limit utility in guiding the medical care of EMS providers. Many of the state protocols in this

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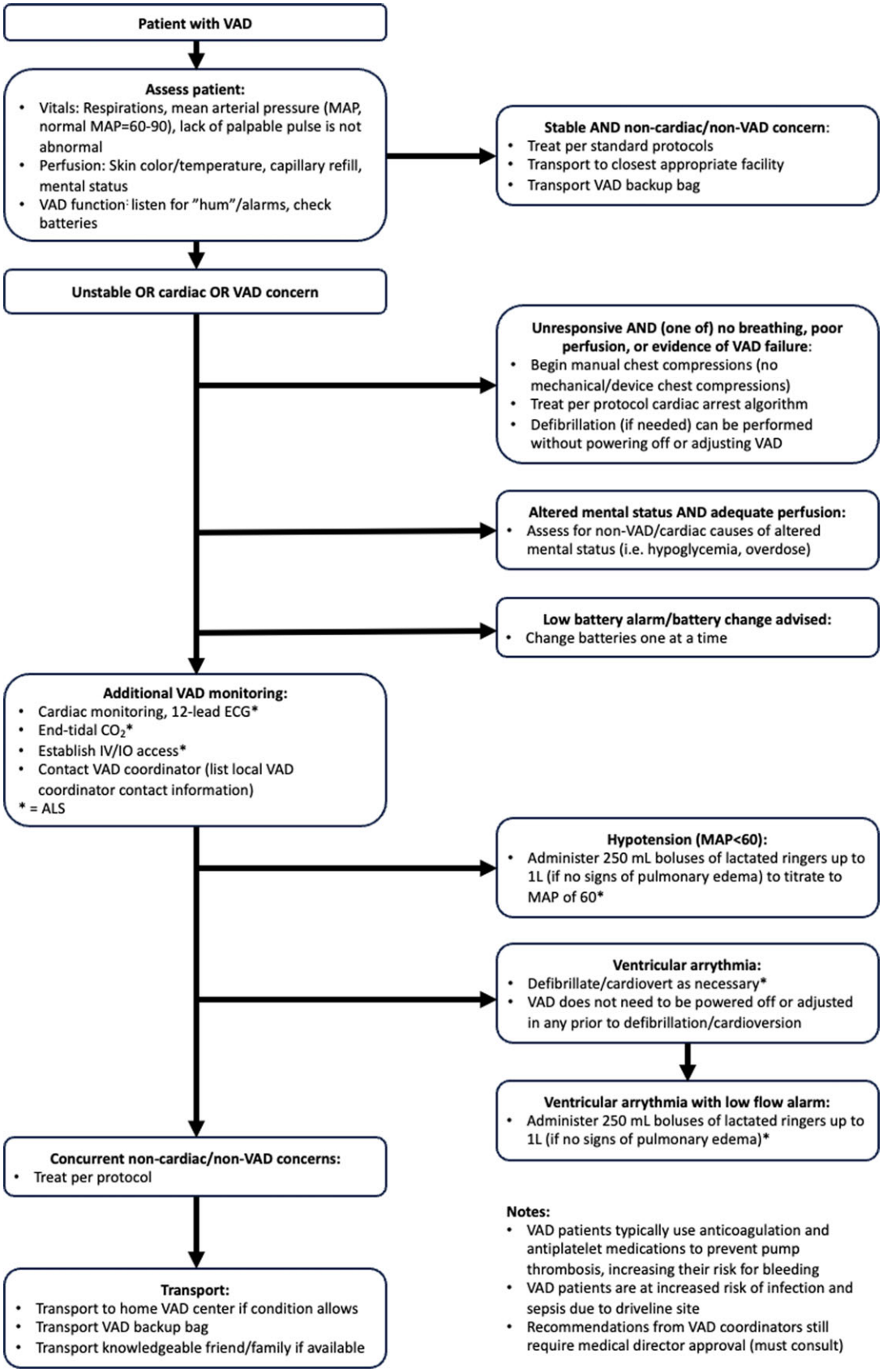

Figure 1. States with State-Wide Ventricular Assist Device (VAD) Protocols.
Abbreviations: EMS, Emergency Medical Services; VAD, ventricular assist device.

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Variable	Overall (n=21)
Perfusion	
Mental Status	16 (76%)
Skin Color	15 (71%)
Skin Temperature	4 (19%)
Capillary Refill	7 (33%)
Blood Pressure	
Mean Arterial Pressure (MAP)	15 (71%)
Appropriate MAP Range Provided	7 (33%)
Pulse	
Noted Pulse May Not be Palpable	17 (81%)
VAD	
Listen for Hum	20 (95%)
Listen for Alarms	20 (95%)
Check Power/Batteries	15 (71%)

Table 1. EMS Protocols for Assessment of Patients with Ventricular Assist Devices
Note: Variables listed as n (%).
Abbreviations: MAP, mean arterial pressure; VAD, ventricular assist device; EMS, Emergency Medical Services.

Variable	Overall (n = 21)
VAD Coordinator Contacts Listed	5 (24%)
When to Contact VAD Coordinator	
All Calls	12 (57%)
Unconscious, Unresponsive, or Cardiac Problem	3 (14%)
VAD-Related Problem	8 (38%)
Change Batteries One at a Time (if indicated)	5 (24%)
Transport VAD Materials/Backup Bag	18 (86%)
Chest Compressions	
Consult Hospital to Start Chest Compressions	3 (14%)
No Mechanical Chest Compressions	2 (10%)
Specific Indications to Begin Chest Compression Listed	18 (86%)

Table 2. EMS Protocols for Treatment of Patients with Ventricular Assist Devices
Note: Variables listed as n (%).
Abbreviations: VAD, ventricular assist device; EMS, Emergency Medical Services.

study advised transport of the VAD materials; the guidelines recommend this, in addition to possibly transporting a knowledgeable friend or family member who are often trained on VAD emergency care.

A standardized algorithm for the care of VAD patients in EMS would be of significant value. Thus, the authors have combined the results of this study with current guidelines to design an algorithm for the prehospital care of patients with VADs (Figure 2). This algorithm highlights specific assessment tools for patients with VADs, differentiates and escalates care for VAD, cardiac, and high-acuity concerns, and addresses treatment for VAD-related conditions.

Limitations

The results of this study are limited by geography, number of states included, implementation, and protocol differentiation by provider level. First, this study only included states within the United States. The prehospital systems of other countries can significantly vary from those of the United States, thus the findings of this study may not apply to other countries. Next, only a subset of states was included in the analysis due to lack of state-wide protocol availability. Therefore, protocols for the care of patients with VADs in states without state-wide protocols were not reported. However, with 32 (63%) states included, the states included represent the majority of the United States and can likely be used to represent the states not included in the analysis. Another barrier is the temporal delay that sometimes occurs in the deployment of EMS protocols. Often, there is a period of months or years, as training and equipment are deployed, before EMS protocols are widely adopted; so, what is written in the protocols may not accurately reflect practice. Further study analyzing the real-life implementation of these protocols would be of interest. Finally, protocols were not stratified by provider level (ie, emergency medical technician [EMT] versus paramedic). For example, while almost all paramedic crews have access to a monitor that can assess MAP, a valuable metric for a patient with

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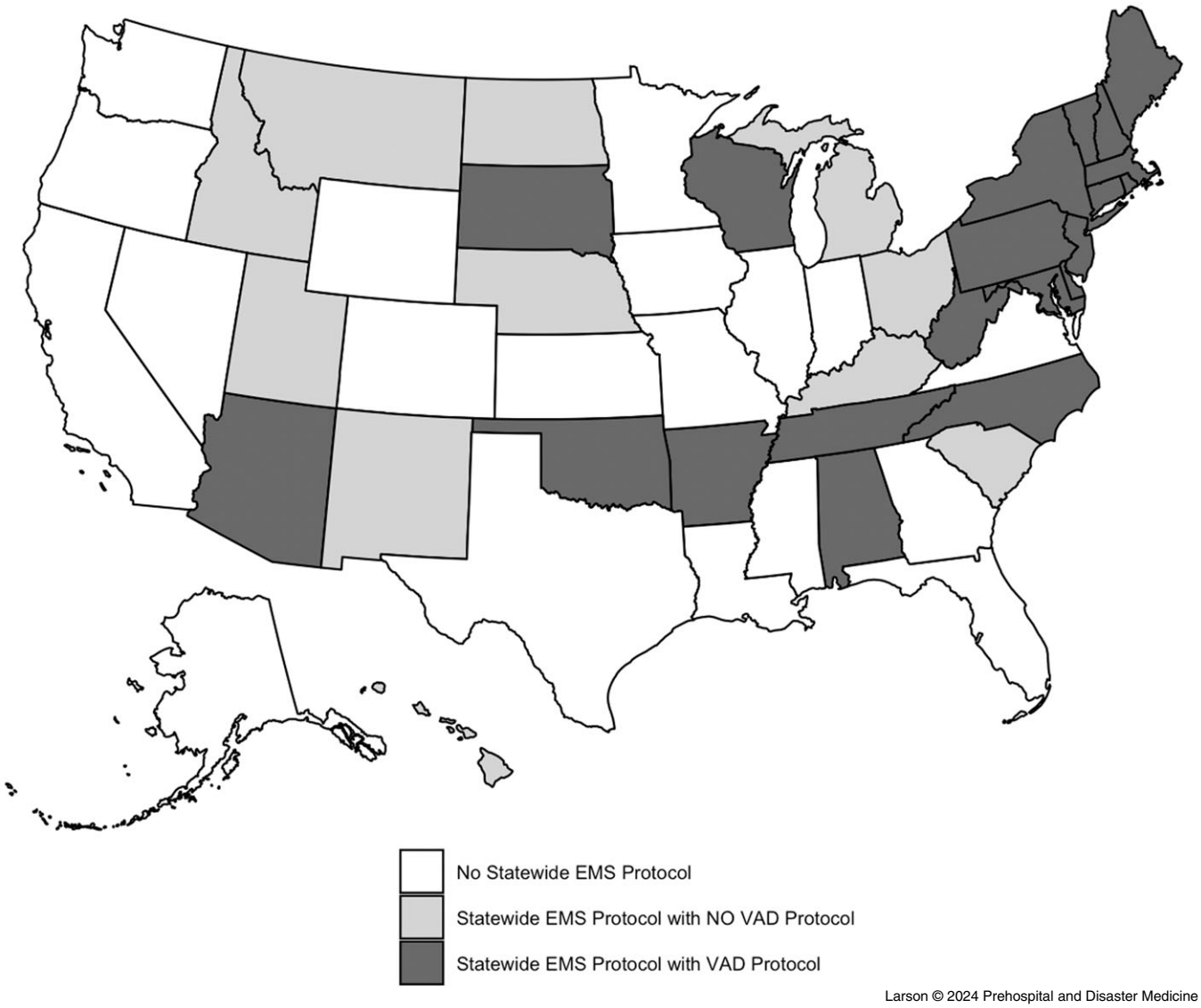

Figure 2. Algorithm for Prehospital Care of Patients with Ventricular Assist Devices (VADs).
Abbreviations: VAD, ventricular assist device; MAP, mean arterial pressure; ALS, Advanced Life Support.

a VAD, many EMT crews would be limited to a manual blood pressure cuff that cannot assess MAP, so such guidance on MAP would not be of use to the EMT providers. With the small sample size of this study, such stratification by provider level was not feasible, but creating guidelines that account for differences in provider level may be of use going forward.

Conclusions

This national analysis of EMS protocols found VAD-specific EMS protocols are not universally adopted in the United States and are variable when implemented, highlighting the opportunity and need for VAD teams to partner with EMS agencies to inform protocols that optimize care for patients with VADs.

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