JACC: CASE REPORTS VOL. 29, 2024

CASE REPORT

CLINICAL CASE

A Shocking Discovery

Electrostatic Discharge-Induced Pump Failure in an Implantable Left Ventricular Assist Device

Mary Quien, MD,[a] Danielle Paquette, DNP, MS,[b] Mario Montealegre-Gallegos, MD,[c] Christopher Szabo, MD,[c] Muhammed Anwer, MD,[b] Ronny Munoz-Acuna, MD[c]

ABSTRACT

Despite advancements in left ventricular assist device (LVAD) technology, numerous complications continue to be associated with these devices. The interactions between LVADs and other electronic devices and the effects of electrostatic discharge (ESD) are not well established. This study reports a rare case of ESD causing pump malfunction in an implantable LVAD. (J Am Coll Cardiol Case Rep 2024;29:102392) © 2024 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

A 69-year-old woman with a history of ischemic cardiomyopathy presented to the hospital with worsening heart failure symptoms. Despite optimization of medical therapy, the patient's symptoms persisted, and she ultimately underwent a HeartMate 3 left ventricular assist device (LVAD) (Abbott) placement as destination therapy.

The patient's hospital course was marked by several complications, including right ventricular failure necessitating temporary right ventricular assist device placement, acute renal failure requiring continuous renal replacement therapy, persistent respiratory failure requiring tracheostomy placement, and decubitus ulcers. These challenges resulted in severe deconditioning of the patient and a prolonged stay in the intensive care unit.

On postoperative day 48, the patient's LVAD emitted several low-flow alarms. The alarms persisted despite fluid resuscitation and reduction of the device's speed.

LEARNING OBJECTIVES

- To identify a rare complication related to LVADs to bring awareness to a life-threatening complication.
- To review LVAD-related adverse events to improve monitoring of complications postimplantation.
- To illustrate the workup of an LVAD alarm to provide a differential diagnosis in this patient population.

PAST MEDICAL HISTORY

The patient had a history of ischemic heart disease with an ejection fraction of 25% to 30%, coronary

From the [a]Department of Cardiovascular Disease, Bridgeport Hospital, Yale New Haven Health, Bridgeport, Connecticut, USA; [b]Department of Cardiothoracic Surgery, Yale New Haven Hospital, New Haven, Connecticut, USA; and the [c]Department of Anesthesia, Critical Care and Pain Medicine, Yale New Haven Hospital, Yale School of Medicine, New Haven, Connecticut, USA.
The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received March 22, 2024; revised manuscript received May 3, 2024, accepted May 10, 2024.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2024.102392

ABBREVIATIONS AND ACRONYMS

ESD = electrostatic discharge

LVAD = left ventricular assist device

artery disease status post-coronary artery bypass graft, and atrial fibrillation.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis of LVAD low-flow alarms includes hypovolemia, right ventricular failure, arrhythmias, cannula (ie, inflow, outflow) obstruction or thrombosis, cardiac tamponade, cannula malposition, and device malfunction.

INVESTIGATIONS

The patient was hypotensive with increased vasopressor requirements, and a bedside transthoracic echocardiogram revealed an underfilled left ventricle, which improved after we administered intravenous fluids and decreased the LVAD speed. Right ventricular function remained unchanged from baseline. There was no pericardial effusion. Despite these interventions, the low-flow alarm persisted. We subsequently performed an arterial-contrast computed tomography to rule out hemorrhage, device obstruction, and pump thrombosis. After switching to the iPAD monitor, we confirmed that in addition to the low-flow episodes, the pump was intermittently shutting off for several seconds at a time. Despite replacing the LVAD controller, meticulously verifying all connections for integrity, and thoroughly inspecting the power cable for any disruptions, the problem persisted.

MANAGEMENT

On examination by the device representative, the logs revealed that the alarms were associated with brief pump stoppages ranging from 3 to 5 seconds, after which the pump returned to its programmed flow as evidenced by the sudden drops in motor speed (continuous blue line) seen in **Figure 1B**, followed by significant drops in average flow and calculated the pulsatility index. This pattern raised concerns about potential electrostatic discharge (ESD) interference. This particular LVAD is designed to automatically reset in response to high static discharge events, a characteristic noted in all 17 incidents captured by the controller. To assess the cause of the ESD, we evaluated the patient room for recent changes in equipment or electronic devices. The introduction of an air-fluidized therapy bed (Envella Air Fluidized Therapy Bed), specifically brought in to treat the patient's decubitus pressure ulcers, was the only recent change. The onset of the alarms coincided with the arrival of this new bed, so the patient's original bed was reinstated, after which no further events were documented during the rest of the intensive care unit stay.

DISCUSSION

With the rising prevalence of implanted LVADs and improved postimplant survival rates, health care providers must be vigilant to detect complications. In the initial year postimplantation, 80% of LVAD patients require hospital readmission, with infection and bleeding ranking among the most prevalent adverse events.[1-3]

Device malfunction, although infrequent, can result in serious consequences. However, the specifics about the type of malfunction are often not reported.[2,3] Some of these device malfunctions can be attributed to ESD. Even though the mechanism is poorly understood, the Food and Drug Administration has documented several instances of medical device malfunction resulting from ESD.[4] Particularly concerning LVADs, an older HeartWare model was recalled due to increased susceptibility to ESD.[5,6] Additionally, a case report highlights pump malfunction caused by ESD, stemming from the seemingly innocuous act of wearing fleece clothing.[7] Although there is a lack of publications addressing more recent instances of malfunction attributed to ESD, it becomes crucial to consider ESD when LVADs trigger alarms, especially considering the proliferation of various medical devices in today's age.

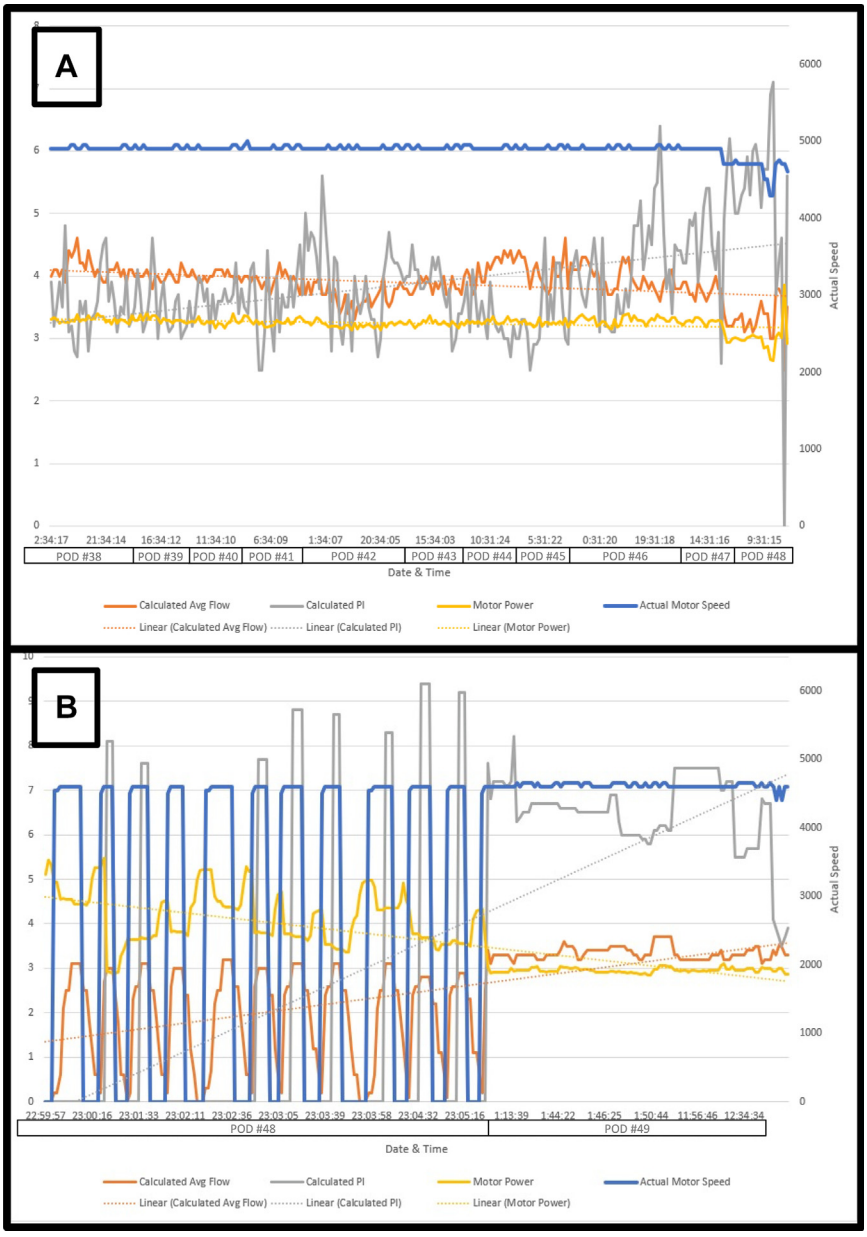
FOLLOW-UP

The alarms stopped when the original bed was reinstated, and there were no further incidents with device alarms. Unfortunately, the patient later developed intestinal pneumatosis and was transitioned to comfort-focused care.

CONCLUSIONS

This case highlights an infrequent complication associated with LVADs. Health care providers should remain suspicious of ESD as a potential cause of persistent low-flow alarms in LVAD patients once the more common causes have been ruled out.

FIGURE 1 **Waveforms Obtained From the Left Ventricular Assist Device Controller**



The power needed to operate the motor (continuous yellow line) and motor speed (continuous blue line) are used to calculate the flow through the device (continuous orange line). The PI (grey line), which is a surrogate for arterial pulse, is calculated by averaging the increases in flow caused by ventricular contraction over a set period. (A) Data from the week before showing stable motor function, calculated average flow and calculated PI until the initial EDS event on the far right of the graph after changing to an air-fluidized therapy bed on January 7, 2024. (B) Continued EDS events throughout January 7, 2024, while on the air-fluidized therapy bed, showing periodic and sudden drops in motor power and speed, suggesting brief pump stoppages, leading to subsequent significant drops in flow and PI, and setting off the low-flow alarm. After bed exchange, around January 8, 2024, all parameters returned to stable function. Avg = average; EDS = electrostatic discharge, PI = pulsatility index; POD = postoperative day.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr Ronny Munoz-Acuna, Department of Anesthesia, Critical Care and Pain Medicine, Yale New Haven Hospital, 20 York Street, New Haven, Connecticut 06510, USA. E-mail: ronny.munoz-acuna@yale.edu. @CoffeeMusicICU.

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KEY WORDS cardiac assist devices, cardiovascular disease, echocardiography, left ventricle, systolic heart failure