Is a Palpable Pulse Always Restored During Cardiopulmonary Resuscitation in a Patient With a Left Ventricular Assist Device?

Authors

Nicholas A. Haglund, MD, Kelly Schlendorf, MD, MS, Mary Keebler, MD, Charu Gupta, MD, Simon Maltais, MD, PhD, E. Wesley Ely, MD, MPH and Daniel Lenihan, MD

Abstract: End-stage heart failure patients are being supported with continuous flow left ventricular assist devices (CF-LVAD) in increasing numbers. The severe physiologic and pharmacologic derangements associated with end-stage heart failure therapies predispose these patients to delirium. During a delirious episode, a patient may inadvertently disconnect CF-LVAD equipment, which may have dangerous consequences. Unfortunately, it is not yet routine to use readily available clinical monitoring tools to allow early detection of delirium in this high-risk population. The authors present a case of acute hyperactive delirium leading to pump power disconnection and cardiopulmonary arrest occurring 7 days after CF-LVAD implantation. The case highlights the need for delirium awareness in the cardiovascular intensive care unit and the unique challenges associated with resuscitation of CF-LVAD patients. The authors propose that cardiovascular intensive care unit patients undergo at least twice daily delirium monitoring and provide a novel resuscitation algorithm for patients who have CF-LVADs.

Key Indexing Terms: Left ventricular assist device; Delirium; Code algorithm; Heart failure. **[Am J Med Sci 2014;347(4):322–327.]**

Continuous flow left ventricular assist devices (CF-LVAD) are the current standard of care for patients with end-stage heart failure (HF) requiring long-term mechanical circulatory support.[1] Patients are implanted with an LVAD for bridge to transplantation or destination therapy (DT) strategies depending on preimplant candidacy for cardiac transplantation. The Interagency Registry for Mechanically Assisted Circulatory Support database demonstrated increasing utilization of LVAD support for patients with end-stage HF, especially for CF-LVADs implanted for DT indications.[2] With increasing utilization of CF-LVAD therapy, experience in managing postoperative CF-LVAD complications is paramount for optimizing clinical outcomes.[3] Despite excellent durability of clinical outcomes with CF-LVADs, patients implanted for DT have worse outcomes when compared with patients implanted for bridge to transplantation, reflecting a higher incidence of comorbidities that have precluded transplantation and no alternative options in the event of life-threatening device complications.[2,3]

The common causes of cardiopulmonary arrest that affect any other hospitalized patient may lead to clinical deterioration of a CF-LVAD patient. In addition, these patients are at risk for device malfunction, driveline disconnection, loss of battery or outlet power and pump thrombosis, all of which are typically life threatening. Moreover, patients dependent on mechanical circulatory support may be particularly prone to developing acute delirium, the consequences of which may be catastrophic. Even for providers well acquainted with CF-VAD technology, continuous-flow physiology presents challenges for the rapid and accurate assessment of vital signs and hemodynamic status. For providers less familiar with mechanical circulatory support technology, the CF-LVAD patient remains a novelty. Resuscitation of a patient with a CF-LVAD may be necessary until identification and reversal of the precipitating event can be determined. Currently, no recommendations exist for delirium screening or cardiopulmonary resuscitation (CPR) in hospitalized patients with CF-LVADs.[1,4–8]

Because of the paucity of guidance regarding rapid clinical assessment of CF-LVAD patients, we present a case of a patient who developed acute delirium 7 days after CF-LVAD implantation and was found unresponsive and disconnected from his CF-LVAD power supply, requiring emergent evaluation and CPR. Recognition and management of delirium and development of a standardized resuscitation algorithm may improve awareness and outcomes in emergency situations involving hospitalized CF-LVAD patients.

CASE PRESENTATION

A 34-year-old man with end-stage ischemic cardiomyopathy, a history of chronic pain treated with narcotics and recent active tobacco abuse underwent elective HeartMate-II CF-LVAD (Figure 1) implantation for DT indications. Intraoperatively, defibrillation was necessary because of recurrent ventricular fibrillation; however, the operation was otherwise uncomplicated. Right ventricular dysfunction was noted when the patient was weaned from cardiopulmonary bypass, and the decision was made to transfer to the intensive care unit (ICU) with the chest left open. The thoracic cavity was closed without difficulty on postoperative day (POD) 1. The patient was weaned from mechanical ventilation on POD 2. He developed a fever with an increased white blood cell count to 20,000 cells/mm on POD 3 without an obvious source of infection and in the setting of routine postoperative antibiotics. Vasoactive medications were weaned off on POD 4. Postoperative pain and anxiety were significant requiring intravenous and oral narcotic pain management and benzodiazepine medications to relieve anxiety. CF-LVAD pump parameters were usual and

From the Divisions of Cardiovascular Medicine (NAH, KS, MK, CG, DL) and Cardiothoracic Surgery (SM), Vanderbilt University Medical Center, Nashville, Tennessee; and VA-GRECC (Geriatric Research Education Clinical Center) (EWE), VA Tennessee Valley Health Care System, Vanderbilt University Medical Center, Nashville, Tennessee.

Submitted August 12, 2013; accepted in revised form October 8, 2013.

N.H. was funded by the Training in Cardiovascular Research Grant T32 HL007411. D.L. received consultancy fees from AstraZeneca, Roche and Singulex and grant from Acorda, Inc.

The authors have no financial or other conflicts of interest to disclose.

Correspondence: Nicholas A. Haglund, MD, Division of Cardiovascular Medicine, Vanderbilt University Medical Center, 1215 21st Avenue South, Suite 5209, Nashville, TN 37232 (E-mail: nicholas.a.haglund@vanderbilt.edu).

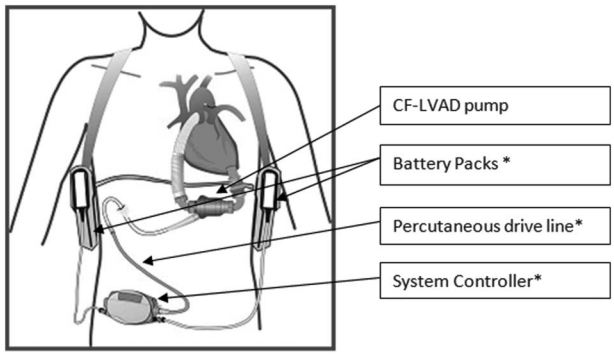

FIGURE 1. HeartMate-II LVAD continuous flow pump with battery packs, percutaneous driveline and system controller (*equipment that is outside the body).

unremarkable (Figure 2A). He was transferred from the ICU to a step down cardiac floor on POD 6. On POD 7, a "code blue" was called after a nurse recognized a HeartMate-II "high priority alarm" and found the patient unresponsive, cyanotic and face down on the floor with both batteries disconnected from the system controller.[9] CF-LVAD power was immediately restored. After chest auscultation confirmed the presence of pump sounds, chest compressions were withheld. However, no peripheral pulse was palpable, and the oxygen saturation probe did not function in the absence of a palpable pulse. He was emergently intubated with subsequent improvement in cyanosis. A Doppler measured brachial blood pressure was obtained with a mean arterial blood pressure of 60 mm Hg and CF-LVAD indices showed a low pulsatility index; therefore, intravenous fluid bolus and dopamine were initiated. He remained unresponsive during CPR and was transferred to the ICU for observation.

Interrogation of the CF-LVAD revealed normal power consumption trends and the absence of suction events; however, there was confirmation of a pump stoppage event because of power source disconnection. Emergent echocardiography ensured normal CF-LVAD function and absence of right ventricular failure or tamponade (Figure 3). Telemetry monitoring revealed atrioventricular sequential paced rhythm and internal cardiac defibrillator interrogation did not show preceding arrhythmia or device therapies. Computed tomography of the brain was normal. Blood cultures and electrolytes remained unremarkable. By POD 26, the patient exhibited full neurologic recovery and was discharged from the hospital. After extensive review and discussion with the patient, his family and physician and nursing providers, the causative factor of cardiopulmonary arrest was determined to be inadvertent pump power disconnection by the patient in the setting of acute delirium.

DISCUSSION

This case provides important information to hospital providers by presenting (1) the first reported case of acute delirium in a postcardiothoracic surgery CF-LVAD patient and (2) as a consequence of the acute delirium event, we discuss how to objectively evaluate and resuscitate a CF-LVAD patient with acute hemodynamic collapse. We emphasize the importance of delirium awareness and suggest the routine use of validated clinical tools to diagnose delirium given the potential for increased morbidity and mortality in patients who have a mechanical circulatory support device. Finally, we propose a novel algorithm to guide clinicians in the emergent resuscitation of a hospitalized CF-LVAD patient.

Delirium

Delirium is an acute, fluctuating, confusional state characterized by changes in cognition and consciousness. The underlying organic pathophysiology of delirium and interactions with environmental risk factors that cause delirium are poorly elucidated and believed to be multifactorial.[10,11] Table 1 summarizes common delirium risk factors. Delirium occurs frequently in patients in the ICU and specifically in patients who have advanced HF, have undergone cardiothoracic surgeries and have prolonged cardiopulmonary bypass; however, delirium has not been reported in patients with CF-LVADs.[4,10,12–15] Importantly, the consequences of delirium in a patient population dependent on mechanical circulatory support could rapidly result in death. Delirium is an independent predictor of poor outcomes, including longer hospital and ICU length of stay, higher cost, readmissions and mortality.[12] Our patient had multiple risk factors for delirium including end-stage HF, tobacco abuse, chronic pain syndrome with narcotic dependence, polypharmacy, depression, recent prolonged cardiopulmonary bypass exposure and ICU stay.

Diagnosis and Treatment of Delirium

The diagnosis of delirium can be made clinically by a 2-step process using validated arousal assessment tools such as the Richmond Agitation Sedation Scale or the Sedation-Agitation Scale combined with delirium assessment tools such as the Confusion Assessment Method for the ICU or the Intensive Care Delirium Screening Checklist.[4,12,16–21] In addition, hypoactive or hyperactive motoric subtypes of delirium can be determined from using a combination of arousal and delirium assessment tools.[4,12] It was recently demonstrated that the hypoactive delirium subtype was the most prevalent and unrecognized type of delirium in the cardiovascular surgery ICU.[12]

The prevention of delirium is paramount; however, treatment options can be divided into 2 basic approaches:

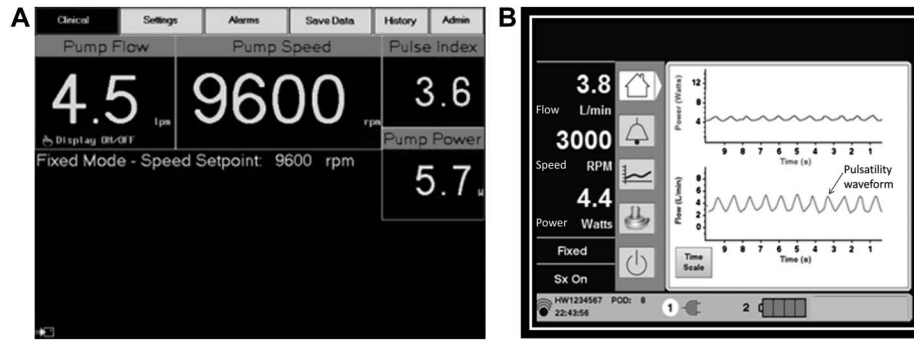

FIGURE 2. LVAD screen shot images for 2 commonly implanted continuous flow pumps:(A) screen shot of the HeartMate-II left ventricular assist device;(B) screen shot of the HeartWare left ventricular assist device.