

## Peritoneal Dialysis Following Left Ventricular Assist Device Placement and Kidney Recovery: A Case Report



Michael Ajuria, Douglas D. Franz, John T. Morris III, Graham Abra, and Wael F. Hussein

Acute kidney injury (AKI) complicates up to 50% of left ventricular assist device (LVAD) placements and up to 30% of these patients require dialysis. Despite advances in LVAD technology since the first-generation devices, the risk for AKI remains high. We present a case of a woman in her 50s with previously stable stage C heart failure who developed critical cardiogenic shock and resultant AKI. She required continuous kidney replacement therapy both before and after placement of an LVAD. Following multiple inpatient and outpatient hemodialysis sessions complicated by hypotension, she was transitioned to peritoneal dialysis (PD). She tolerated PD well, and her kidney function continued to improve during the following weeks. After 6 weeks of outpatient PD, she recovered kidney function, allowing for cessation of dialysis. PD is a good option for patients with advanced heart failure who receive an LVAD due to gentler ultrafiltration, decreased risk for bacteremia, and better preservation of kidney function as compared with hemodialysis.

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### INTRODUCTION

The Randomized Evaluation of Mechanical Assistance for the Treatment of Congestive Heart Failure study in 2001 demonstrated superior outcomes after left ventricular assist device (LVAD) placement compared with optimal medical management in patients with end-stage heart failure ineligible for a heart transplant.<sup>1</sup> Since this trial, there have been significant advancements in LVAD technology, with improving survival in patients receiving continuous flow LVADs from 2012 to 2014 compared with 2008 to 2011. Despite these improving outcomes, acute kidney injury (AKI) still complicates ~50% of LVAD implants in patients with advanced heart failure, and up to 30% of those with AKI require dialysis.<sup>2</sup> These patients are typically managed with hemodialysis, which presents several clinical and logistic challenges. Many of these challenges may be abrogated with the use of peritoneal dialysis (PD).

### CASE REPORT

We present a woman in her 50s with a history of hypertension, obesity, and nonischemic heart failure with left ventricular ejection fraction of 20%. Her ejection fraction subsequently improved to 50% with medical management. Nine years after the initial diagnosis, she was admitted for a heart failure exacerbation with ejection fraction back down to 25% and required inotropic therapy. Left heart catheterization showed no new ischemic cause. She was discharged after diuresis with a creatinine level of 1.2 mg/dL and an estimated glomerular filtration rate of 47 mL/min.

Two months following this hospitalization, the patient was readmitted with a repeat heart failure exacerbation and was found to have a left ventricular thrombus. She was started on continuous infusions of dobutamine and furosemide. Her creatinine level trended up to 2.5 mg/dL, attributed to cardiorenal syndrome, and she was started on

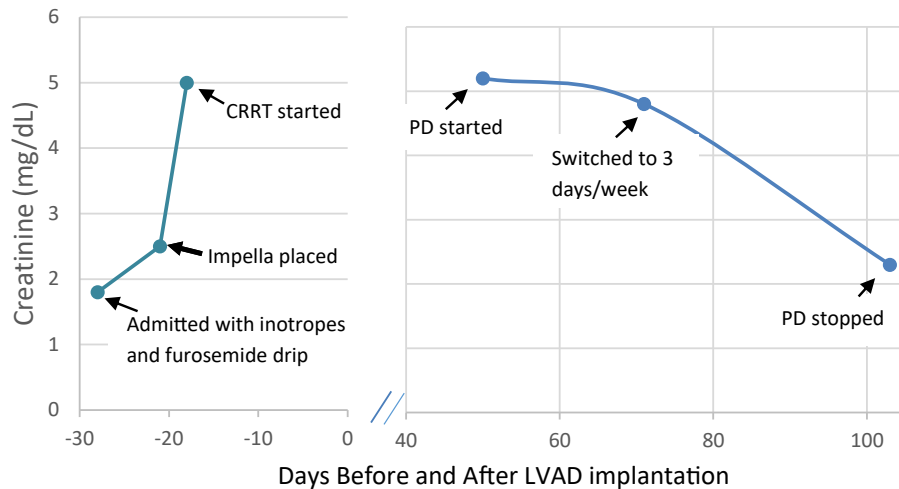
treatment with vasopressors and had an Impella device placed for hemodynamic support. Despite these measures, her creatinine level continued to increase, peaking at 5 mg/dL before continuous kidney replacement therapy was started, due to oliguria, volume overload, and hypotension. She continued to require continuous kidney replacement for 25 days due to hypotension (Fig 1).

After evaluation by the advanced heart failure committee, the patient's kidney failure was determined to be acute and likely reversible because her creatinine level in the weeks preceding the AKI was acceptable for an LVAD. A Heartmate II LVAD was implanted as destination therapy, with a heart transplant not approved at the time because of her kidney function. A week later, she transitioned to intermittent hemodialysis and a tunneled hemodialysis catheter was placed. Her hemodialysis sessions were complicated by intradialytic hypotension despite a decrease in ultrafiltration, for which she was given 25 g of albumin each treatment.

During the hospitalization, PD was presented as a management option to address her intradialytic hypotension and long-term dialysis given the rural location of her home. More than a month after the LVAD was implanted, a PD catheter was placed in the hospital with a plan to continue receiving outpatient hemodialysis for 2 weeks post-PD catheter insertion. She was discharged to local housing after a 9-week hospitalization.

Unfortunately, during the patient's first outpatient hemodialysis session, she again developed intradialytic hypotension and was admitted to the hospital out of concern for an infectious cause. The workup was negative for infection and she was able to start receiving PD during this hospitalization. Subsequently, she was discharged with continued training at a home dialysis unit close to her home.

The patient was prescribed a continuous cycler PD regimen of 5 cycles of 2 L each with a combination of



**Figure 1.** Creatinine level trend before and after left ventricular assist device (LVAD) placed. Abbreviations: CRRT, continuous renal replacement therapy; PD, peritoneal dialysis.

1.5% and 2.5% dextrose over 9 hours nightly with a dry day. Her medications included spironolactone, 25 mg, daily; aspirin; potassium chloride, 20 mEq, daily; midodrine, 10 mg, 3 times daily; warfarin; and epoetin alfa, 20,000 units, weekly.

Three weeks later, the patient was seen at the home dialysis clinic. Her creatinine level had improved and she reported an increase in urine output, so her PD frequency was reduced to 3 nights weekly. A month later, her creatinine level further decreased to 2.3 mg/dL and she was able to discontinue PD, 3 months after LVAD implantation. Recently she was seen in the LVAD clinic with a creatinine level of 2.1 mg/dL, with estimated glomerular filtration rates remaining between 22 and 26 mL/min since discontinuing PD. She was pursuing heart transplant listing at multiple transplantation centers, almost 2 years after discontinuing dialysis.

## DISCUSSION

The standard of care for treatment of refractory advanced heart failure remains orthotopic heart transplantation, but this option is limited due to the availability of organs. As a result, an increasing number of patients are managed with LVADs either as a bridge to heart transplantation or as destination therapy. The number of LVADs implanted each year increased from around 400 in 2008 to more than 2,100 in 2017.<sup>3,4</sup>

The HeartMate II study in 2009 demonstrated improved survival, decreased stroke risk, and decreased kidney failure requiring dialysis with a newer continuous flow device as compared with the older pulsatile flow devices.<sup>5</sup> Despite the reported improved outcomes in that study, a national cohort of patients receiving LVADs between 2008 and 2013 experienced high rates of AKI and many required dialysis. Approximately 1 in 2 patients who required

dialysis died during their hospital stay.<sup>2</sup> Since then, the HeartMate 3 is now the prevailing device being implanted. However, it is unknown whether there is any benefit with this device in regard to kidney function or dialysis need.

The American Heart Association has issued guidelines for patient selection of LVADs for heart failure. LVADs are not recommended as destination therapy for patients receiving dialysis or anticipated to receive dialysis. However, LVADs may be considered as a bridge to heart and kidney transplantation if outpatient dialysis is feasible.<sup>6</sup> Kidney function generally improves in the months following LVAD placement; however, outcomes are poor for patients with pre-existent kidney disease.<sup>7</sup> In-hospital mortality in 1 study was 50%, 15%, and 10% for patients with end-stage kidney disease, chronic kidney disease not receiving dialysis, and without chronic kidney disease, respectively.<sup>8</sup>

Management of patients receiving maintenance dialysis on LVAD support can be challenging. Because most LVADs are continuous-flow devices, many patients do not have pulsatile blood pressures. Blood pressure can be measured using a Doppler device and a manual blood pressure cuff. As the blood pressure cuff is deflated, the first appreciable sound over the brachial artery is considered the mean arterial pressure (MAP).<sup>9</sup> The goal MAP is typically ~80 mm Hg. An MAP > 90 mm Hg has been associated with increased risk for stroke and pump thrombosis.<sup>10</sup> MAP readings < 80 mm Hg can lead to symptoms of hypotension and syncope, in addition to LVAD low flow alarms from insufficient blood flow to the device inflow pump. The heart failure team typically manages the settings of the LVAD device, including pump speed. Increasing the pump speed increases the ventricular support of the device. However, too fast of a pump speed can also lead to a decrease in preload and low flow alarms. Ultrafiltration during dialysis can lead to “suction events” in which low

left ventricular volume causes low ventricular pressure, decreases flow to the LVAD, and can lead to ventricular arrhythmias. Dialysis nurses are often unfamiliar with the care of these patients and many outpatient hemodialysis units will not accept patients with LVADs.

PD was previously contraindicated in patients with LVADs due to location of the driveline in the peritoneum and risk for infection. However, drivelines in newer smaller devices are outside the peritoneum. PD has been used successfully in patients with LVADs<sup>11,12</sup> and has several benefits compared with hemodialysis. First, due to the need for a central venous dialysis catheter in most patients with LVADs, hemodialysis is associated with a higher incidence of bacteremia than PD. Catheter-related bloodstream infections can be devastating and may require surgical intervention and potentially removal of the LVAD.

Second, the slow daily ultrafiltration of PD offers greater hemodynamic stability with a lower ultrafiltration rate as compared with hemodialysis.<sup>13</sup> For example, if during a given week, 3 L are removed each 3-hour hemodialysis session in a 70-kg person, this translates to an ultrafiltration rate of 14 mL/kg per hour. The same amount of fluid removed over a given week by nightly PD over 9 hours is ~2 mL/kg per hour.

Third, PD is associated with more preserved residual kidney function in patients with end-stage kidney disease as compared with hemodialysis, especially early in a patients' dialysis vintage, possibly due to avoidance of repeat ischemic insults.<sup>14</sup> Preserved residual kidney function is associated with higher quality of life and lower mortality.<sup>15</sup>

Patients who are transitioned home after placement of an LVAD have training in device management that is similar to home dialysis training. They are instructed to chart blood pressures and weights and perform driveline care in a similar fashion to PD patients, who also track vitals and perform PD catheter exit-site care. Therefore, it is reasonable to expect that patients with an LVAD (or their caregivers) can effectively manage PD.

In the inpatient setting, there may be barriers for using PD in patients with a recently implanted LVAD and AKI. Cardiothoracic surgeons and cardiologists may be more comfortable and familiar with hemodialysis. Although guidelines for the use of PD in AKI exist, local experience with its use may be limited.<sup>16</sup> Other barriers to PD for LVAD patients include the additional surgery required for PD catheter placement, inpatient dialysis nurse availability for PD education before discharge, and outpatient availability for "urgent-start" PD if the PD catheter has not been in place for 2 weeks before discharge. Additionally, PD as a home modality for the treatment of AKI is not currently covered by the Centers for Medicare & Medicaid Services. Multidisciplinary discussions with other specialists, as well as reimbursement changes to outpatient PD for AKI, may increase the use of PD in the setting of patients with LVADs.

In summary, PD is a good option for patients on LVAD support who require kidney replacement therapy due to

the decreased risk for bacteremia, gentle ultrafiltration, and potentially preserving residual kidney function allowing for kidney recovery, as in our patient. Further studies are needed to determine whether PD is a superior modality for kidney replacement therapy in patients on long-term LVAD support.

## ARTICLE INFORMATION

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