

HEART FAILURE AND CARDIOMYOPATHIES

CLINICAL CASE

Pregnancy and Delivery Care for a Patient With a HeartMate 3



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ABSTRACT

BACKGROUND The limited available data on pregnancies among patients with left ventricular assist devices (LVADs) in situ shows elevated rates of maternal and fetal/neonatal morbidity and mortality. The first fully magnetically levitated device providing centrifugal continuous flow, HeartMate 3 (HM3, Abbott), is the only LVAD available in the United States since 2018 and has fewer adverse patient outcomes compared with previous devices.

CASE SUMMARY A 32-year-old G5P2113 woman became pregnant 19 months after destination-therapy HM3 LVAD placement. Uncomplicated antepartum care and a cesarean delivery at 34 weeks under neuraxial anesthesia was facilitated by our institution's pregnancy heart team.

DISCUSSION This represents the second reported HM3-supported pregnancy resulting in a live birth. Various barriers to care guided a shared anticoagulation plan, and no hemorrhagic or thrombotic complications occurred. Our intrapartum monitoring strategy facilitated a patient-centered delivery and postpartum experience while maintaining excellent patient safety. (JACC Case Rep. 2025;30:103536) © 2025 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

We present a 32-year-old G5P2113 woman with a history of nonischemic cardiomyopathy and end-stage heart failure due to noncompaction cardiomyopathy, diagnosed remote from pregnancy. She became pregnant 1 year after heart failure diagnosis, and the pregnancy was complicated by decompensated heart failure necessitating delivery at 32 weeks, with significant intraabdominal adhesive disease noted at the

time of cesarean section, postpartum hemorrhage requiring emergent uterine artery embolization, and postpartum cardiogenic shock. She was not a transplant candidate at our center owing to presenting in cardiogenic shock with severe combined pre- and post-pulmonary hypertension, along with a high burden of allosensitization, so she underwent placement of a HeartMate 3 (HM3) left ventricular assist device (LVAD) as destination therapy. Despite birth control recommendations and counseling against

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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](#).

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ABBREVIATIONS AND ACRONYMS

- HM3** = HeartMate 3
- LVAD** = left ventricular assist device
- NICU** = neonatal intensive care unit
- TTE** = transthoracic echocardiography

future pregnancies, she became pregnant 19 months after LVAD placement.

MANAGEMENT

When pregnancy was confirmed at 5 weeks gestational age, the patient was counseled by maternal-fetal medicine and advanced heart failure doctors about the risks associated with pregnancy. Termination was recommended, but the patient desired to continue pregnancy.

After counseling regarding anticoagulation options in pregnancy, she elected to switch to adjusted-dose enoxaparin (1 mg/kg twice daily). The patient had

TAKE-HOME MESSAGES

- HM3 devices have lower risk of thrombotic complications than earlier-generation LVADs, and less aggressive anticoagulation strategies may be acceptable in patients with HM3 LVAD-supported pregnancies.
- An intraoperative management strategy including arterial line, continuous noninvasive advanced hemodynamic monitoring, continuous point-of-care ultrasound, and infusions of vasoactive medications can facilitate a more patient-centered delivery involving spinal-epidural neuraxial and early postoperative mobility.

VISUAL SUMMARY Framework for Delivery Planning

Who	Patient Condition	- 32yo G5P2113 - HM3 in situ - Mildly decreased RV function - Concern for focal accrete
	Patient Risk	- mWHO IV
	Pregnancy Heart Team	- Maternal-Fetal Medicine - Obstetric Anesthesiology - Cardiothoracic Anesthesiology - Obstetric Cardiology - Advanced Heart Failure Cardiology - Ventricular Assist Device (VAD) Team
What	Delivery	- Scheduled repeat cesarean delivery
When	Term	- Preterm delivery at 34 weeks gestational age (GA)
Where	Type of Medical Center	- Cardiothoracic OR at an academic center
	Maternal Levels of Care	- Level IV
	Society for Obstetric Anesthesia & Perinatology (SOAP) Centers of Excellence	- Yes
How	Anesthetic & Medication Plan	- Low dose combined spinal-epidural (CSE) - Vasopressors: Phenylephrine boluses, Norepinephrine infusion - Inotropes: Epinephrine infusion
	Access & Monitoring	- 2 large bore PIVs - PICC line - Arterial line - Cardiac point of care ultrasound (POCUS)
	Postpartum Hemorrhage Management	- Oxytocin infusion
	Recovery	- Cardiothoracic intensive care unit (CTICU) - Heparin infusion bridged to Warfarin - Hypertensive management with VAD speed adjustment and initiation of enalapril
Take-home messages	1. HM3 devices have lower risk of thrombotic complications than prior generation LVADs, and less aggressive anticoagulation strategies may be acceptable in patients with HM3 LVAD-supported pregnancies.	
	2. An intraoperative management strategy including arterial line, continuous noninvasive advanced hemodynamic monitoring, continuous point of care ultrasound, and infusions of vasoactive medications can facilitate a more patient-centered delivery involving spinal-epidural neuraxial and early postoperative mobility.	

considerable barriers to care because of geographic distance from our center, financial constraints, and caregiving obligations, and before pregnancy she had difficulties maintaining adherence to anticoagulation and VAD program clinic visits. In this setting, after shared decision making with the patient and engaging clinical social work, we elected to dose enoxaparin to target a peak anti-Xa activity level of 0.8-1.2 IU/mL rather than targeting trough levels. The patient reported inconsistent enoxaparin use throughout pregnancy (corroborated by laboratory assessment) and was offered to return to warfarin, but she elected to continue enoxaparin. Cessation of potentially teratogenic guideline-directed medical therapy was recommended. Aspirin was continued for preeclampsia prophylaxis.

Throughout her pregnancy, her care was discussed at monthly meetings of our institution’s pregnancy heart team, a multidisciplinary team including maternal-fetal medicine, obstetrical anesthesiology, obstetrical cardiology, and advanced heart failure cardiology. She underwent monthly echocardiograms with increases in her VAD speed from 5,300 to 5,800 rpm throughout pregnancy, titrated by symptoms and echocardiogram findings (Table 1).

Given a history of 2 previous cesarean deliveries, another cesarean delivery was recommended, to which the patient was amenable. Our team recommended delivery at 34 weeks’ gestation. This gestational age was selected, in collaboration with the patient, by balancing the risks of iatrogenic prematurity with safety concerns regarding her residing more than 2.5 hours from our center without reliable access to transportation, potentially resulting in an unscheduled delivery at a center less familiar with her care and less able to provide coordinated care for her needs, her difficult previous surgical history, and difficulties with anticoagulation adherence. She underwent uncomplicated cesarean delivery in a cardiac operating room under low-dose combined spinal-epidural neuraxial analgesia (3 mg hyperbaric 0.75% bupivacaine) with intermittent epidural boluses of 2% lidocaine with epinephrine and sodium bicarbonate (3-5 cc) (Figure 1). Intraoperative monitoring included an arterial line, continuous noninvasive advanced hemodynamic monitoring (Acumen IQ, Edwards Biosciences), and continuous cardiac point-of-care ultrasound with grossly stable left ventricular internal diameter in diastole and right ventricular function noted throughout (Figure 1). At the time of delivery, when an increase in cardiac output is required, epinephrine was initiated to augment right ventricular function. Systemic vascular resistance was supported with a norepinephrine infusion

TABLE 1 Monitoring Parameters Throughout Pregnancy

GA, wk	VAD Speed, rpm	Flow, m/s	RV Systolic Dysfunction	LVIDd, cm	MR	EFW, g (%ile)
Pre-pregnancy	5,300	3.6	Moderate	6.3	Moderate	-
12	5,300	4.2	Moderate	5.9	Moderate	-
13	5,400	-	-	-	-	-
16	5,400	3.3	Moderate	5.8	Moderate	-
17	5,500	-	-	-	-	-
20	5,500	4.5	Moderate	5.8	Severe	-
23-24	5,800	4.7	Mild	6.4	Severe	536 (14)
30	-	-	-	-	-	1,492 (21)
PPD2	5,800	3.8	Moderate	6.3	Moderate	-
PPD7	5,600	-	-	-	-	-

EFW = estimated fetal weight; GA = gestational age; LVIDd = diastolic left ventricular internal diameter at diastole; MR = mitral regurgitation; PPD = postpartum day; RV = right ventricle; VAD = ventricular assist device.

(0.04-0.08 µg/kg/min) and phenylephrine boluses as the neuraxial anesthesia was titrated. The baby was born weighing 2,005 grams with APGAR scores of 8 and 9 at 1 and 5 minutes, respectively, and was transferred to the neonatal intensive care unit (NICU) due to prematurity. The placenta had no abnormal findings on pathology report. A bilateral tubal ligation was performed concurrently per patient request. After delivery, an oxytocin infusion was started and gradually weaned (60 U/h to 18 units/h over 30 min) to minimize postpartum hemorrhage risk. Norepinephrine and epinephrine were slowly weaned over 9 hours postoperatively.

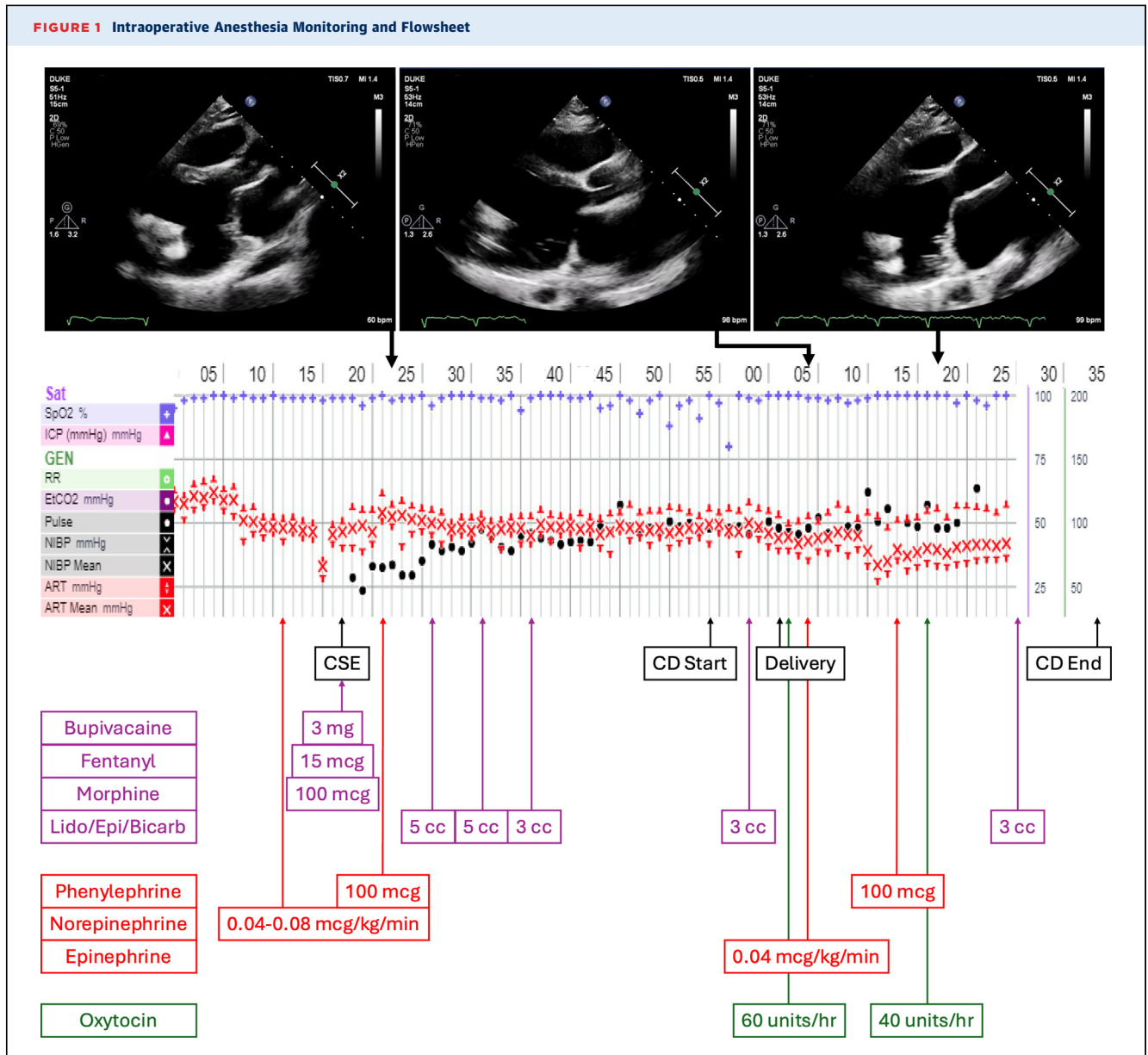
Postoperatively, she recovered initially in the cardiac surgery intensive care unit. She was initially placed on a heparin infusion, which was bridged to warfarin (goal international normalized ratio [INR]: 2-3). On postpartum day 7, LVAD speed was decreased from 5,800 to 5,600 rpm and she was started on low-dose enalapril owing to persistent hypertension with doppler mean arterial pressure of 102-108 mm Hg (goal ≤90 mm Hg).

OUTCOME AND FOLLOW-UP

She was discharged home on postoperative day 8 once she was on therapeutic warfarin. Her infant was discharged on day 13 of life without complication. She was doing well as of 2 months postpartum.

DISCUSSION

To our knowledge, this is the second reported pregnancy resulting in live birth in a patient with a HM3 LVAD and the ninth reported viable delivery of an LVAD-supported pregnancy,¹ with 3 additional reported cases ending in early losses or terminations^{2,3} (Table 2). HM3 is the first fully magnetically levitated

FIGURE 1 Intraoperative Anesthesia Monitoring and Flowsheet

LVAD providing centrifugal continuous flow. Compared with the older-model HeartMate II (HM2) LVAD, HM3 has demonstrated improved survival free from disabling stroke or device exchange due to pump thrombosis, as well as lower rates of bleeding and hemolysis.⁴

Pregnancy is contraindicated in LVAD-supported pregnancies owing to concerns for high maternal and fetal morbidity and mortality. This case demonstrates many unique aspects of our care model designed to minimize this risk in a high-risk patient who opted to pursue pregnancy. Most notably, our multidisciplinary model potentially improved this

patient's outcome through improved team familiarity and established lines of communication with regular patient discussions. Within this framework, we developed and implemented a flexible management strategy to optimize antepartum, intrapartum/intraoperative, and postpartum care involving various medical teams across multiple hospital units. We recommend that patients with severe cardiac comorbidities in pregnancy be managed by similar teams.

The hypercoagulable state of pregnancy justifies recommendations for intensive anticoagulation therapy and monitoring in LVAD-supported pregnancies. It is notable that our patient did not

TABLE 2 Characteristics of Reported LVAD-Supported Pregnancies^a

First Author	Pregnancy Outcome	Device	Delivery Monitoring	Delivery Location	Delivery Mode
Sims et al ¹¹	Live birth	HMII	PAC, arterial line, TTE	-	SVD
LaRue et al ¹²	Live birth	HMII	PAC, arterial line, TEE	Cardiac OR	CD
Yadalam et al ¹	Live birth	HM3	-	-	CD
Makdisi et al ¹³	Live birth	HMII	PAC, TEE	Cardiothoracic OR	CD
Collins et al ¹⁴	Live birth	-	-	Cardiothoracic OR	CD (failed IOL)
Gayam et al ¹⁵	Live birth	HeartWare	Arterial line, central venous line, PAC	Cardiothoracic ICU/cardiothoracic OR	CD (failed IOL)
Malik et al ¹⁶	Live birth	HeartWare	PAC, arterial line	Cardiac ICU for IOL; unspecified OR	CD (failed IOL)
Vargas et al ¹⁷	Live birth	HeartWare	-	-	Repeat CD
Schroeder et al ^{2,3}	Preivable delivery	-	-	-	-
Wu et al ³					
A	First-trimester termination	HM3	-	OR	Uterine aspiration
B	Second-trimester termination	HM3	Arterial line	Cardiac ICU	IOL

TABLE 2 Continued

First Author	Delivery Timing	Discharge Day	Maternal Complications	Neonatal Complications
Sims et al ¹¹	Spontaneous labor at 34 wk	-	-	-
LaRue et al ¹²	36 wk according to Ballard examination; unscheduled, due to worsening maternal status	14	Anemia; transfusion 8 units pRBC	Respiratory distress, CPAP, apnea, and bradycardia or prematurity
Yadalam et al ¹	34 wk, scheduled	-	LV inflow cannula thrombus; anemia; transfusion 3 units pRBC intraoperatively; intraabdominal bleeding requiring uterine artery and anterior internal iliac artery embolization, 5 additional units pRBC transfusion	-
Makdisi et al ¹³	32 wk, scheduled	8	-	Apnea requiring intubation, NICU admission
Collins et al ¹⁴	34 wk, scheduled	11	Multifocal pneumonia	Discharged on day of life 13
Gayam et al ¹⁵	34 wk, scheduled	-	-	-
Malik et al ¹⁶	34 wk, scheduled	11	Hospital-acquired pneumonia	NICU
Vargas et al ¹⁷	32 wk, unscheduled, due to decompensating maternal status	-	Thrombus formation, pulmonary edema	RDS, NICU
Schroeder et al ^{2,3}	-	-	Maternal death	Neonatal death
Wu et al ³				
A	-	2	-	-
B	-	4	-	Anatomy ultrasound with marked oligohydramnios and placentomegaly

^aThe authors of this case report noted significant detail changes to preserve autonomy.

Arterial line = arterial line; CD = cesarean delivery; CPAP = continuous positive airway pressure; HM3 = HeartMate 3; HMII = HeartMate II; ICU = intensive care unit; IOL = induction of labor; LV = left ventricular; NICU = neonatal intensive care unit; OR = operating room; PAC = pulmonary arterial catheter; pRBC = packed red blood cells; RDS = respiratory distress syndrome; SVD = spontaneous vaginal delivery; TEE = transesophageal echocardiography; TTE = transthoracic echocardiography.

experience thrombotic complications, particularly given her inconsistent anticoagulation use. The Society for Maternal-Fetal Medicine (SMFM) and the International Society for Heart and Lung Transplantation (ISHLT) recommend concomitant administration of either warfarin (goal INR 2-3) or enoxaparin with aspirin for pregnant patients with an LVAD to reduce the risk of LVAD thrombosis; the recommendation for warfarin vs enoxaparin is nuanced and varies with warfarin dose and gestational age.⁵ In SMFM guidance, it is recommended to target both peak (0.8-1.2 IU/mL) and trough 0.6 IU/mL activity levels when using enoxaparin; ISHLT

recommends a peak goal of 0.7-1.2 IU/mL.⁶ HM3 has demonstrated a uniquely low thrombotic risk compared with earlier models,⁴ and a recent randomized controlled trial⁷ in nonpregnant HM3 recipients demonstrated that withholding aspirin did not increase thromboembolic complications and reduced bleeding risk. Less aggressive anticoagulation regimens such as ours (targeting only the peak goal in the manner of ISHLT, rather than both peak and trough as SMFM recommends) may be sufficient after a shared decision-making discussion. We acknowledge that the experience of one patient is insufficient for generalized conclusions, and that

larger, more varied samples of patients with this rare situation are necessary.

Close monitoring during labor can support a smooth delivery experience while ensuring high levels of patient safety. Using a peripherally inserted central catheter line and large-bore intravenous lines instead of an internal jugular central venous line or pulmonary artery catheter helped ease the postpartum transition and facilitated NICU visits. Neuraxial analgesia enabled the patient's partner to be present at delivery, and our patient was able to hold her baby in the operating room before NICU transfer—a practice linked to a lower risk of postpartum depression. Mental health is an essential consideration for this group of patients, as preterm delivery and serious pregnancy complications increase the risk of postpartum depression. Our interventions aimed to reduce this risk.

This case demonstrates that transesophageal echocardiography and invasive monitoring with a pulmonary artery catheter can be deferred in lieu of other techniques, such as continuous cardiac point-of-care compression ultrasound (POCUS) and data from the Acumen IQ cuff. Cardiac POCUS during this crucial time of delivery and the subsequent 30-60 minutes allows for adequate examination of ventricular filling volume and contractile function to provide inotropic therapy titrated to these real-time TTE images around the time of delivery. Given the patient's baseline reduction in right ventricular function, we anticipated myocardial dysfunction from increased preload at the time of uterine involution and administered prophylactic epinephrine and did not need further titration.⁸⁻¹⁰ Curating an operating room team familiar with managing possible adverse outcomes can minimize morbidity and further permit less invasive monitoring. Given our patient's increased placenta accreta spectrum risk from 2 prior cesarean deliveries and uterine artery embolization, we

anticipated possible prolonged surgical time and postpartum hemorrhage with associated risk of hemodynamic instability. The cesarean delivery was performed in a cardiac operating room by our complex obstetrical surgery team with an anesthesiologist with expertise in both cardiothoracic and obstetrical anesthesia.

CONCLUSIONS

As technology supporting cardiac function in patients with heart failure continues to improve, the number of reproductive-age women with LVADs will likely increase. Still requiring multidisciplinary expert care and frequent monitoring, the HM3 may support relatively lower-risk pregnancies compared with earlier LVAD models, allowing for a management approach that balances safe monitoring with attention to patient preferences.

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KEY WORDS anesthesia, anticoagulation, cardiac assist devices, cardiomyopathy, heart failure, pregnancy

 **APPENDIX** For a video summarizing the case, please see the online version of this paper.