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Survival of Pregnant Coronavirus Patient on Extracorporeal Membrane Oxygenation

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A 27-year-old woman presented at 23 weeks' 6 days' gestation who tested positive for the coronavirus disease 2019 (COVID-19). Despite mechanical ventilation and paralysis, she remained hypoxic and was emergently cannulated for veno-venous extracorporeal membrane oxygenation (VV-ECMO). The patient ambulated while intubated and on VV-ECMO. She was decannulated and extubated. An ultrasound demonstrated an appropriately grown fetus without abnormalities. She was discharged to home and gave birth to a healthy baby girl at 39 weeks' gestation. Using VV-ECMO, this patient and her fetus survived acute hypoxemic respiratory failure due to COVID-19.

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Information regarding the impact of coronavirus disease 2019 (COVID-19) on pregnant women who require veno-venous extracorporeal membrane oxygenation (VV-ECMO) is limited. This case describes the survival of a pregnant patient with COVID-19 who was successfully discharged to her home and had a healthy birth after treatment including VV-ECMO.

The patient is a 27-year-old woman who presented with a history of fever, cough, and sore throat at 23 weeks' 6 days' gestation. She tested positive for COVID-19 and presented to the emergency department with new-onset nausea, vomiting, and shortness of breath. Risk factors included work at a long-term care facility. The patient's medical history included 1 prior cesarean section with arrest of descent at term and a history of postpartum preeclampsia. Her pregnancy otherwise had been uncomplicated.

She had a mild transaminitis, hypokalemia, and proteinuria. The patient had a witnessed tonic-clonic seizure accompanied by urinary incontinence, followed by a postictal state. Examination revealed no evidence of preterm labor or rupture of membranes.

The patient was emergently intubated. A chest roentgenogram revealed right lower-lobe consolidation and bilateral patchy infiltrates. The patient was transferred to our facility for management of her respiratory distress secondary to COVID-19 given the potential for premature delivery requiring neonatal intensive care unit management of a periviable fetus.

She was admitted to the medical intensive care unit in acute hypoxemic respiratory failure due to acute respiratory distress syndrome (ARDS) secondary to COVID-19. Prone positioning was not possible, so the patient was paralyzed to promote better patient synchrony with lung protective mechanical ventilation under sedation. She remained hypoxic on ventilator settings, with a fraction of inspired oxygen of 100% and a positive end-expiratory pressure of 16 mm Hg. Her ratio of arterial oxygen partial pressure–to–fractional inspired oxygen was 66 mm Hg, and it was determined that the patient would need emergent VV-ECMO.

A multidisciplinary discussion was had concerning whether delivery was indicated given her acutely worsening status. Given the patient had been normotensive throughout her course, her seizure was not felt to be consistent with eclampsia. There was no clear evidence that delivery at this gestational age would improve maternal respiratory status in the setting of ARDS and COVID-19 pneumonia. The fetal survival on ECMO was considered better than a periviable delivery. The risk of severe hemorrhage after emergent cesarean delivery given the need for anticoagulation at cannulation and initiation was discussed. The decision was made to pursue delivery while on support for maternal indications only.

The patient was taken emergently to the operating room for cannulation and initiation of VV-ECMO. A 31F bicaval dual lumen VV-ECMO cannula was inserted using the right internal jugular vein and under transesophageal echocardiography and fluoroscopic guidance, and outflow was confirmed. Anticoagulation with a continuous heparin drip was managed using thromboelastography and partial thromboplastin time with the thromboelastography reaction time goal 2 to 3 times higher than normal and the partial thromboplastin time goal of 90 seconds. There were no signs of bleeding or thrombotic complications throughout therapy. Flows were maintained at 3 to 4 L/min. After cannulation, the patient followed commands and moved purposefully. Continuous video electroencephalogram monitoring was initiated and did not reveal any seizure or epileptiform activity. Convalescent plasma was administered on hospital day 4. Daily fetal monitoring revealed normal fetal heart tones and fetal movement.

On hospital day 8, the patient ambulated while intubated and on VV-ECMO. The patient was successfully weaned off VV-ECMO and decannulated at the medical intensive care unit bedside. The patient was extubated on hospital day 10, and a detailed obstetric ultrasound

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demonstrated an appropriately grown fetus without abnormalities on anatomic survey and normal amniotic fluid. She had oxygen saturations measuring 100% on room air and was discharged to home on hospital day 14. At 39 weeks' gestation, the patient gave birth to a healthy baby girl.

Comment

Evidence regarding the impact of COVID-19 on pregnant women is limited. Available retrospective cohort studies suggest the risk of severe disease in pregnant women is similar to the general population. The management of pregnant women with COVID-19 is challenging because there can be overlap with the symptoms and signs of preeclampsia, including proteinuria and transaminitis.[1] Delivery would have been indicated if the patient's seizure was due to eclampsia, but her course was not consistent with this pregnancy complication.

The indications for VV-ECMO are unchanged regardless of COVID-19 status. Maximizing therapies for ARDS, such as prone positioning, is recommended before cannulation and initiation of VV-ECMO.[2]

The use of VV-ECMO to treat ARDS during pregnancy started during the novel influenza A (H1N1) pandemic in 2009.[3] More recently, the maternal and fetal survival rates of patients on ECMO support during pregnancy were reported as 77.8% and 65%, respectively. Uterine compression on the inferior vena cava may interfere with flows in cases of femoral cannulated VV-ECMO. Hemodynamic changes that may negatively affect uterine perfusion may be avoided by using VV-ECMO through a single right internal jugular vein dual-lumen cannula during pregnancy. Other complications of ECMO in pregnancy include bleeding, hemolysis, cannula dislodgement, and infection.

Despite acute decompensation in patients with COVID-19, blind cannulation is discouraged, and the use of roentgenography, fluoroscopy, ultrasonography, and echocardiography is recommended.[4] Strategies to optimize protection of the fetus may be used. Radiation exposure and the extent of time under sedation for the procedure may be limited by being performed by an experienced cannulating surgeon.[5]

When considering a preterm delivery while on ECMO, the risk of fetal morbidity and death due to prematurity at the current gestational age must be balanced with the risks of fetal death related to ongoing critical maternal illness and therapy.[6]

There is growing evidence that anticoagulation of patients with COVID-19 leads to better outcomes. The current recommendation is to follow the institutional guidelines for anticoagulation on ECMO for COVID-19 as in other disease states.[7]

Convalescent plasma has been used in the treatment of patients with COVID-19, was well tolerated, and could potentially improve the outcomes in severe COVID-19 cases. Convalescent plasma was previously delivered to a pregnant patient critically ill with COVID-19 on ECMO support, with complete recovery.[8]

References

1. Chen L, Li Q, Zheng D, et al. Clinical characteristics of pregnant women with COVID-19 in Wuhan, China. *N Engl J Med*. 2020;382:e100.
2. Combes A, Brodie D, Bartlett R, et al. Position paper for the organization of extracorporeal membrane oxygenation programs for acute respiratory failure in adult patients. *Am J Respir Crit Care Med*. 2014;190:488-496.
3. Saad AF, Rahman M, Maybauer DM, et al. Extracorporeal membrane oxygenation in pregnant and postpartum women with H1N1-related acute respiratory distress syndrome: a systematic review and meta-analysis. *Obstet Gynecol*. 2016;127:241-247.
4. Pacheco LD, Saade GR, Hankins GDV. Extracorporeal membrane oxygenation (ECMO) during pregnancy and postpartum. *Semin Perinatol*. 2018;42:21-25.
5. Moon EK, Wang W, Newman JS, Bayona-Molano MDP. Challenges in interventional radiology: the pregnant patient. *Semin Intervent Radiol*. 2013;30:394-402.
6. Zhang JJY, Ong JA-H, Syn NL, et al. Extracorporeal membrane oxygenation in pregnant and postpartum women: a systematic review and meta-regression analysis. *J Intensive Care Med*. 2021;36:220-228.
7. Tang N, Bai H, Chen X, Gong J, Li D, Sun Z. Anticoagulant treatment is associated with decreased mortality in severe coronavirus disease 2019 patients with coagulopathy. *J Thromb Haemost*. 2020;18:1094-1099.
8. Duan K, Liu B, Li C, et al. Effectiveness of convalescent plasma therapy in severe COVID-19 patients. *Proc Natl Acad Sci USA*. 2020;117:9490-9496.