

Extracorporeal life support during pregnancy

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ABSTRACT

Objectives: To review the literature on extracorporeal life support (ECLS) during pregnancy to determine its efficacy and safety for the mother and fetus.

Methods: A comprehensive literature search was obtained from MEDLINE via [PubMed.gov](http://pubmed.gov) and from [ScienceDirect.com](http://sciencedirect.com) using the following search queries: ECLS and pregnancy, extracorporeal membrane oxygenation (ECMO) and pregnancy, ECMO and H1N1 influenza, acute respiratory distress syndrome (ARDS) and pregnancy, pregnancy and H1N1 influenza, and Extracorporeal Life Support Organization registry.

Results: Our literature search produced 332 articles for review. A total of 45 patients treated with ECLS or ECMO during pregnancy were reported in 26 publications. Postpartum patients were not included. Indications for ECLS were severe H1N1 influenza with ARDS ($n = 33$), other ARDS ($n = 8$), cardiogenic shock ($n = 3$), and cardiac arrest ($n = 1$). The mean gestational age was 26.5 weeks (range, 12-38 weeks), and the median duration of ECLS was 12.2 days (range, 1-57 days). The survival rate was 77.8% (35 of 45) for mothers and 65.1% (28 of 43) for fetuses. In addition, we report a 25-year-old pregnant patient with hantavirus cardiopulmonary syndrome unresponsive to pressors and inotropes. The patient was placed on venoarterial ECMO for 72 hours, recovered without complications, and delivered a healthy infant. The mother and son remain asymptomatic 6 years later.

Conclusions: ECLS during pregnancy is effective and relatively safe for the mother and fetus. The first successful use of ECLS in a pregnant patient with life-threatening hantavirus cardiopulmonary syndrome is being reported together with this review. (*J Thorac Cardiovasc Surg* 2016;151:1154-60)

A previously healthy 25-year-old pregnant patient presented in respiratory failure was diagnosed with hantavirus cardiopulmonary syndrome (HCPS). She remained severely hypoxic despite mechanical ventilation, and developed worsening hypotension refractory to inotropic and vasoactive medications. The patient was placed on venoarterial (V-A) extracorporeal life support (ECLS) for 72 hours, after which she recovered without complications and delivered a healthy infant. A review of our case is what led us to examine the maternal and fetal outcomes of ECLS during pregnancy.

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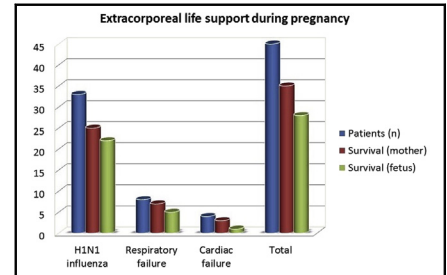
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Maternal and fetal survival of all reported cases of ECLS during pregnancy.

Central Message

Extracorporeal life support during pregnancy is effective and relatively safe for the mother and fetus.

Perspective

The aim of this study was to review the literature on extracorporeal life support (ECLS) during pregnancy to determine its efficacy and safety. A comprehensive literature search revealed that the use of ECLS or extracorporeal membrane oxygenation during pregnancy has been reported in only 45 patients. The survival rate was 77.8% for mothers and 65.1% for fetuses. In conclusion, ECLS is effective and relatively safe during pregnancy.

See Editorial Commentary page 1161.

Previous publications on ECLS and extracorporeal membrane oxygenation (ECMO) during pregnancy consist of case reports or small case series, the vast majority involving pregnant women with severe H1N1 influenza complicated with acute respiratory distress syndrome (ARDS). The aim of the present study was to review the available literature on all reported cases requiring ECLS during pregnancy, not including postpartum patients, to determine its efficacy and safety for the mother and fetus.

METHODS

A comprehensive literature search was obtained from MEDLINE via [PubMed.gov](http://pubmed.gov) and from [ScienceDirect.com](http://sciencedirect.com) using the following search queries: ECLS and pregnancy; ECMO and pregnancy; ECMO and H1N1

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Abbreviations and Acronyms

ARDS	= acute respiratory distress syndrome
ECLS	= extracorporeal life support
ECMO	= extracorporeal membrane oxygenation
ELSO	= Extracorporeal Life Support Organization
HCPS	= hantavirus cardiopulmonary syndrome
HPS	= hantavirus pulmonary syndrome
OR	= odds ratio
SNV	= sin nombre virus
V-A	= venoarterial
V-V	= venovenous

influenza; ARDS and pregnancy; pregnancy and H1N1 influenza; Extracorporeal Life Support Organization (ELSO) Registry.

According to the policies of the Institutional Review Board at the University of New Mexico, this study did not require review by the institutional Human Research Review Committee.

Statistical Analysis

Fisher's exact test was used to detect any statistically significant difference in the observed maternal and fetal survival associated with the diagnosis, gestational age, or technique of ECLS. A *P* value < .05 was considered to indicate significance.

RESULTS

We followed PRISMA guidelines in our systematic review of the literature (Figure 1). Our literature search produced 332 articles for review. Only those publications that reported the use of ECLS or ECMO during pregnancy were selected for review. Postpartum patients were not included. A total of 45 patients treated with ECLS or ECMO during pregnancy were reported in 26 publications, which are listed chronologically in Table 1. The first 7 publications on ECLS or ECMO during pregnancy were case reports published between 1991 and 2007.¹⁻⁷ These were profoundly hypoxic pregnant women who needed ECLS because of respiratory failure secondary to varicella pneumonia (*n* = 2), ARDS (*n* = 4), or right heart failure secondary to primary pulmonary hypertension (*n* = 1).⁵

The most common indication for ECLS during pregnancy was severe H1N1 influenza complicated with ARDS (*n* = 33). Fourteen articles that included pregnant women treated with ECMO during the 2009 H1N1 pandemic were published between 2009 and 2014.⁸⁻²¹ The Australia and New Zealand Extracorporeal Membrane Oxygenation Influenza Investigators published 2 reports; to avoid duplication, only the 7 patients listed in the report by Nair and colleagues¹⁵ are included in Table 1. The largest series, published by Dubar and colleagues¹³ from France, reported 11 pregnant women treated with ECMO for severe ARDS secondary to severe H1N1 influenza.

Four additional publications on the use of ECLS during pregnancy included 5 patients, including 1 case of hypoxic cardiac arrest,²² 1 case of ARDS of unknown origin,²³ 1 case of refractory cardiac arrhythmia with cardiogenic shock,²⁴ 1 case of mycoplasma ARDS,²⁵ and 1 case of cardiogenic shock likely of viral origin.²⁵

The mean gestational age of the 45 patients was 26.5 weeks (range, 12-38 weeks). Only 1 patient (2.2%) was placed on ECLS during the first trimester, 19 (42.2%) were placed during the second trimester, and 25 (55.6%) were placed during the third trimester. Venovenous (V-V) cannulation was used in 41 patients with severe respiratory failure, and 4 patients with both cardiac and respiratory failure underwent V-A femoral cannulation for ECLS. The median duration of ECLS was 12.2 days (range, 1-57 days).

The most common ECLS-related complication was bleeding. Major bleeding was reported in 7 articles.^{3,10,15,17,21,22,25} Nair and colleagues¹⁵ reported major bleeding in 57.1% (4 of 7) of their pregnant women while on ECMO, which necessitated packed red blood cell transfusion in relatively large volumes (median volume transfused, 3500 mL) and was the main cause of death. The bleeding sites were intracranial or multiple sites in cases with fatal hemorrhage, and uterine or pulmonary in cases of nonfatal bleeding.¹⁵ Other bleeding problems included hemothorax,^{3,10,21,22} upper gastrointestinal hemorrhage,¹⁷ nonfatal fetal intracranial hemorrhage,¹⁷ vaginal bleeding,²⁵ and bleeding from the cannulation and tracheostomy sites.²⁵ Other reported ECLS-related complications include hemolysis¹⁴; cannula dislodgment³; ineffective flow rate resulting from uterine compression, which improved after emergency cesarean section⁷; and nosocomial infections, including bloodstream, respiratory, urinary tract, and line-related infections.¹⁵

According to our literature review, ECLS during pregnancy is associated with survival rates of 77.8% (35 of 45) in mothers and 65.1% (28 of 43) in fetuses (Table 1). Three maternal deaths were caused by multiorgan system failure, 1 death was attributed to infection, and cause of death was not reported for the other patients. Of the 15 fetal deaths, 5 were intrauterine deaths occurring during ECLS, 3 were stillbirths, 1 occurred during cesarean section delivery, and 1 was an elective abortion. The causes of death were not mentioned for 5 fetal deaths. The maternal and fetal outcomes of all reported cases of ECLS during pregnancy are summarized in Table 2.

A review of maternal and fetal mortality shows that 8 of the 33 pregnant women placed on ECMO during the 2009 H1N1 pandemic did not survive (odds ratio [OR], 24.2%), compared with 2 maternal deaths among the 12 pregnant women placed on ECLS for other indications (OR, 16.7%) (*P* = .50329844). Nine of the 33 fetal deaths occurred in the pregnant women placed on ECMO during

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