Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
TABLE

Intrauterine device choice and concern for complications among patients in clinic for intrauterine device insertion

| Patient IUD preferences and concerns | n (%) |
|--------------------------------------|-------|
| Patient IUD preferences and concerns | n (%) |
| IUD type (n=599)                     |       |
| 52mg-LNG IUD (Mirena)               | 295 (49) |
| Low-cost 52mg-LNG IUS (Liletta)     | 25 (4) |
| 19.5mg-LNG IUS (Kyleena)            | 166 (28) |
| 13.5mg-LNG IUS (Skyla)              | 58 (10) |
| Copper IUD (Paragard)               | 55 (9) |
| Concern for complications (n=533)   |       |
| Ectopic pregnancy                   | 188 (35) |
| Embedded IUD                        | 285 (53) |
| Expulsion                           | 235 (44) |
| Uterine perforation or injury       | 271 (51) |
| Pelvic inflammatory disease         | 156 (29) |
| Unable to see strings or difficult removal | 131 (25) |
| Malpositioned IUD                   | 185 (35) |
| Other                                | 22 (4) |

IUD, intrauterine device; LNG IUS, levonorgestrel-releasing intrauterine system.

Abern. Patient preference for intrauterine device follow-up. Am J Obstet Gynecol 2022.

With recent publications describing the traditional in-office IUD check as having limited use, many clinicians are not advising patients to schedule these appointments. However, our data demonstrate that patients have concerns, and the majority preferred to return to the office for an IUD check. These results indicate that patients should be counseled about the option of an in-office visit for an IUD check. Healthcare providers should encourage patient autonomy in IUD surveillance.

Lauren E. Abern, MD
Kristen A. Kiely, WHNP-BC
Glendell S. de Guzman, MD
Department of Obstetrics and Gynecology
Atrius Health
40 Holland St.
Somerville, MA 02144
labern@emory.edu

Karla E. Maguire, MD, MPH
Department of Women’s Health
Dell Medical School
The University of Texas at Austin
Austin, TX
The authors report no conflict of interest or financial disclosures.

This study was presented in poster format at the 2019 annual clinical and scientific meeting of the American College of Obstetricians and Gynecologists, Nashville, TN, May 3–6, 2019.

REFERENCES

1. Peipert JF, Zhao Q, Allsworth JE, et al. Continuation and satisfaction of reversible contraception. Obstet Gynecol 2011;117:1105–13.
2. Mirena. Placement Mirena. Available at: https://www.mirena-us.com/mirena-birth-control/mirena-insertion. Accessed October 2, 2021.
3. Kyleena. Let’s get started. Available at: https://www.kyleena-us.com/getting-kyleena-iud/iud-placement. Accessed October 2, 2021.
4. Skyla. What to expect. Available at: https://www.skyla-us.com/what-expect. Accessed October 2, 2021.
5. Liletta. What should I expect after Liletta insertion?. Available at: https://www.liletta.com/what-to-expect-after-insertion. Accessed October 2, 2021.
6. Paragard. What can I expect with Paragard?. Available at: https://www.paragard.com/what-can-i-expect-with-paragard/. Accessed October 2, 2021.
7. Steenland MW, Zapata LB, Brahmi D, Marchbanks PA, Curtis KM. Appropriate follow up to detect potential adverse events after initiation of select contraceptive methods: a systematic review. Contraception 2013;87:611–24.
8. Curtis KM, Jatlaoui TC, Tepper NK, et al. US selected practice recommendations for contraceptive use, 2016. MMWR Recomm Rep 2016;65:1–66.

© 2021 Elsevier Inc. All rights reserved. https://doi.org/10.1016/j.ajog.2021.12.025

Extracorporeal membrane oxygenation in pregnancy: a bridge to delivery and pulmonary recovery for COVID-19—related severe respiratory failure

OBJECTIVE: SARS-CoV-2 and its clinical disease, COVID-19, are associated with severe maternal respiratory morbidity and mortality in pregnancy. Extracorporeal membrane oxygenation (ECMO) has been used as a bridge to pulmonary recovery in nonpregnant patients, but there are limited data regarding the management of ECMO in pregnancy. This case series aimed to obtain data on ECMO initiation before delivery in the setting of the ongoing COVID-19 pandemic.

STUDY DESIGN: All pregnant patients with confirmed COVID-19 based on polymerase chain reaction testing were...
| Demographics Month of admission | Median (range) or N % | Case 1 July 2020 | Case 2 July 2020 | Case 3 Jan. 2021 | Case 4 June 2021 | Case 5 July 2021 |
|--------------------------------|-----------------------|------------------|------------------|------------------|------------------|-----------------|
| **Age (y)**                   | 33 (27–43)            | 27               | 43               | 30               | 34               | 33              |
| **Body mass index (kg/m²)**   | 36 (30–45)            | 36               | 35               | 45               | 36               | 30              |
| **Gravida**                   | 2 (2–3)               | 2                | 2                | 2                | 2                | 3               |
| **Parity**                    | 1 (0–1)               | 0                | 0                | 1                | 1                | 1               |
| **Previous OB history**       | 4 (80%)               | No               | CD × 1, PPROM    | CD × 1           | CD × 1           | CD × 1          |
| **Race (non-White)**          | 3 (60%)               | Black            | Latinx           | Latinx           | White            | White           |
| **Health insurance (public)** | 2 (40%)               | Public           | Managed care     | Public           | Private          | Private         |
| **Hypertensive disease**      | 2 (40%)               | Preeclampsia     | No               | No               | No               | No              |
| **Diabetes**                  | 1 (20%)               | No               | Gestational      | No               | No               | No              |
| **Pulmonary disorders**       | 0 (0%)                | No               | No               | No               | No               | No              |
| **Other medical problems**    | 2 (40%)               | No               | No               | Hypothyroidism   | Hypothyroidism   | No              |
| **Gestational age at ECMO**   | 25wk6d                | (24wk6d–30wk5d)  | 30wk5d           | 26wk5d           | 24wk6d           | 25wk1d          | 25wk6d          |
| **Total ECMO length (d)**     | 11 (10–68)            | 11               | 8                | 41               | 68               | 10              |
| **Length of antepartum ECMO** | 10 (1–32)             | 8                | 1                | 32               | 29               | 10              |
| **Birth to decannulation (d)**| 8.5 (3–39)            | 3                | 8                | 9                | 39               | —               |
| **Extubation while on ECMO**  | 1 (20%)               | No               | No               | No               | Yes              | Yes             |
| **Mobilization while on ECMO**| 2 (40%)               | No               | No               | Yes              | Yes              | Yes             |
| **Circuit exchanges**         | 0 (0–4)               | 0                | 0                | 1                | 4                | 0               |
| **Pressor use**               | 4 (80%)               | No               | Yes              | Yes              | Yes              | Yes             |
| **Antihypertensive use**      | 3 (60%)               | Yes              | No               | Yes              | Yes              | No              |
| **Cardiac**                   | 1 (20%)               | No               | No               | No               | Heart block, cardiac arrest | No |
| **Lung**                      | 2 (40%)               | Bronchoscopy mucus plug | No | No | Pneumothorax | No |

Yin. Extracorporeal membrane oxygenation in pregnancy for severe respiratory failure in COVID-19. Am J Obstet Gynecol 2022. (continued)
| Demographics | Month of admission | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|--------------|-------------------|--------|--------|--------|--------|--------|
|              | Jan. 2021 (July 2020 to July 2021) |        |        |        |        |        |
| Infectious   |                   | Pseudomonas pneumonia | Pseudomonas pneumonia | ESBL UTI and pneumonia | Canula site infection | No |
| Renal        |                   | 20%    | 0      | 0      | 0      | 0      |
| Liver        |                   | 20%    | 0      | 0      | HELLp  | No |
| Gastrointestinal |             | 60%    | No     | Dysphagia | Lower bleed | Lower bleed | No |
| Neurologic   |                   | 0%     | 0      | 0      | 0      | 0      |
| Anticoagulation agent (addition to heparin) | | 60% | Heparin | Heparin then argatroban | Heparin then argatroban | heparin then argatroban |
| Venous thromboembolism | | 80% | No | Left popliteal to common femoral and pulmonary embolism | Bilateral external iliac, inferior vena cava, right brachial | Right common femoral | Left gastrocnemius |
| Bleeding complication | | 80% | Disseminated intravascular coagulation | No | Anterior rectus and uterine hematomas, delayed postpartum hemorrhage | Rectus hematoma, postpartum abdominal wash-out and inferior epigastric embolization | Hemolytic anemia with thrombocytopenia |
| Red cells    | 12 (0–48) | 12 | 2 | 42 | 48 | 0 |
| Plasma       | 0 (0–4) | 0 | 0 | 0 | 4 | 0 |
| Platelets    | 1 (0–2) | 2 | 0 | 2 | 1 | 1 |
| Cryoprecipitate | 1 (0–2) | 1 | 0 | 1 | 2 | 1 |
| Anticoagulation at discharge | | 80% | No | Yes, apixaban | Yes, enoxaparin | Yes, apixaban | Yes, enoxaparin |
| Gestational age at birth | 29wk3d (26wk5d-31wk6d) | 31wk6d | 26wk5d | 29wk3d | 29wk2d | — |
| Mode of delivery (CD) | 4 | 100% | Emergent cesarean | Emergent cesarean | Planned cesarean | Planned cesarean | — |
| Indication for delivery | NA | NA | Concern for HELLp vs abruption | Preterm labor | Improving maternal status so delivery to facilitate decannulation | Maternal cardiac arrest with worsening status | — |
| 1-minute Apgar score | 2.5 (1–4) | 4 | 1 | 2 | 3 | — |
TABLE
Use of extracorporeal membrane oxygenation in pregnancy for COVID-19–related respiratory failure and associated outcomes (continued)

| Demographics | Median (range) or N % | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|---------------|----------------------|--------|--------|--------|--------|--------|
| Month of admission | Jan. 2021 | (July 2020 to July 2021) | Case 1 July 2020 | Case 2 July 2020 | Case 3 Jan. 2021 | Case 4 June 2021 | Case 5 July 2021 |
| 5-minute Apgar score | 6 (5—9) | 7 | 5 | 5 | 9 | — |
| UA pH | 7.36 (7.23—7.41) | NA | 7.23 | 7.36 | 7.41 | — |
| UA base excess | 5 (1-5) | NA | 1 | 5 | 5 | — |
| Live birth | 4 100% | Yes | Yes | Yes | Yes | — |
| Birthweight (g) | 1234 (1000—1465) | 1465 | 1000 | 1194 | 1274 | — |
| NICU length of stay (d) | 58 (31—58) | 31 | NA | 65 | 58 | — |
| Neonatal morbidity | NA | NA | Ventilation, bradycardia | Ventilation, persistent ductus | Sepsis, chronic lung disease persistent ductus | Respiratory distress syndrome, anemia | — |
| Neonatal survival to discharge | 4 100% | Yes | Yes | Yes | Yes | — |
| Positive COVID-19 PCR | 0 0% | No | No | No | No | — |
| COVID-19+ antibodies | 1 25% | Yes | No | No | No | — |

Maternal outcomes

| Survival to delivery | 4 100% | Yes | Yes | Yes | Yes | — |
| Survival to discharge | 5 100% | Yes | Yes | Yes | Yes | — |
| Tracheostomy (d) | 10 (0—113) | 16 | 0 | 10 | 113 | 0 |
| Discharged on O₂ | 2 40% | No | No | No | Yes | — |
| Discharge with rehabilitation | 1 20% | No | No | Yes | No | — |
| Total length of stay (d) | 30 (16—80) | 30 | 16 | 55 | 80 | 17 |
| ICU length of stay (d) | 26 (11—77) | 26 | 11 | 49 | 77 | 12 |
| Postpartum mood disorder | 3 75% | Depression | No | Anxiety | Insomnia | — |
| Breastfeeding | 1 25% | No | No | Pumping POD1-POD5, POD11 | No | — |

Neonatal outcomes for case 5 were not available because the pregnancy was ongoing at time of discharge.

CD, cesarean delivery; ECMO, extracorporeal membrane oxygenation; ESBL, extended spectrum beta lactamase; HELLP, hemolysis, elevated liver enzymes, low platelets syndrome; ICU, intensive care unit; POD, postoperative day; PPROM, preterm premature rupture of membranes; UA, umbilical arterial; UTI, urinary tract infection.

* ECMO antepartum time was <1 day (17 hours), rounded up to 1 day.

Yin. Extracorporeal membrane oxygenation in pregnancy for severe respiratory failure in COVID-19. Am J Obstet Gynecol 2022.
identified at the University of California, Los Angeles (UCLA) from March 2020 to August 2021, and those who required ECMO were enrolled (institutional review board approval, #20-000579). Case 1 and 2 were previously described. The Supplemental Table details institutional protocols for COVID-19, ECMO, and delivery management. COVID-19 therapeutics used include remdesivir (4 of 5), dexamethasone (5 of 5), convalescent plasma (3 of 5), and tocilizumab (2 of 5). All patients were cannulated with 2 veno-venous femoral catheters within 2 days of ventilation and placed on heparin as anticoagulation therapy. The partial pressure of O$_2$ to fraction of inspired O$_2$ ratio at ECMO initiation was 94 (range, 54–109) with a Murray score for acute lung injury of 3.5 (range, 3.3–5.0) and a Respiratory ECMO Survival Prediction Score of 5 (range, 3–6). All neonates received steroids for prematurity and were monitored intermittently unless there was a change in the maternal or fetal status.

RESULTS: Of the 25 pregnant patients hospitalized for COVID-19 during the enrollment period, 16 were admitted to the intensive care unit and 5 of them required ECMO for respiratory support. Of those, 4 delivered while on ECMO and 1 was decannulated and discharged with an ongoing pregnancy. All outcomes are presented in the Table and timelines are presented in the Supplemental Figure. Obesity was a risk factor for 5 of 5 patients and 3 of 5 patients belonged to the Black, indigenous, people of color group. ECMO was initiated at a median of 25 weeks and 6 days of gestation. The total median time on ECMO was 11 days (range, 10–68) with 10 days (range, 1–32) of ECMO antepartum. The most common complications occurred in 4 of 5 cases, namely pressor use, infection, venous thromboembolism, and bleeding including postoperative hematomas, disseminated intravascular coagulation, and delayed postpartum hemorrhage. Hematologic morbidity occurred within days of cesarean birth and or decannulation. The median gestational age at birth was 29 weeks 3 days (range, 26 weeks 5 days to 31 weeks 6 days) and all deliveries were by cesarean delivery for a wide range of maternal and fetal indications with 4 of 4 livebirths and neonatal survival to discharge. There was significant neonatal respiratory morbidity with a median neonatal intensive care unit length of stay of 58 days (range, 31–58). The maternal survival to delivery and discharge was 5 of 5, with a total median length of stay of 30 days (range, 16–80). Postpartum mood disorder was commonly diagnosed by psychiatry (3 of 4 cases) and breastfeeding occurred in 1 patient.

CONCLUSION: This case series presents outcomes for the use of ECMO during pregnancy for acute respiratory failure caused by COVID-19. Our findings concur with the 2 other cases in literature, showing that pregnancy can be prolonged on ECMO, delivery on ECMO can be performed safely, and ECMO can serve as a bridge to maternal respiratory recovery. There were high rates of maternal and neonatal survival. Significant hematologic morbidity and neonatal respiratory morbidity were observed. ECMO in pregnancy should be managed with an experienced multidisciplinary team that can make key decisions about initiation, cannulation, timing of delivery, management of complications, and postpartum care.

Ophelia Yin, MD
Michael Richley, MD
Division of Maternal Fetal Medicine
Department of Obstetrics and Gynecology
University of California, Los Angeles
Los Angeles, CA

Joseph Hadaya, MD
Division of Cardiac Surgery
Department of Surgery
University of California, Los Angeles
Los Angeles, CA

Jenny Mei, MD
Thalia Mok, MD
Division of Maternal Fetal Medicine
Department of Obstetrics and Gynecology
University of California, Los Angeles
Los Angeles, CA

Miriam Fahim, MD
Department of Obstetrics and Gynecology
Loma Linda University Health
Loma Linda, CA

Ilina D. Pluym, MD
Rashmi Rao, MD
Division of Maternal Fetal Medicine
Department of Obstetrics and Gynecology
University of California, Los Angeles
Los Angeles, CA

Courtney Martin, MD
Department of Obstetrics and Gynecology
Loma Linda University Health
Loma Linda, CA

Christina S. Han, MD
Division of Maternal Fetal Medicine
Department of Obstetrics and Gynecology
University of California, Los Angeles
Los Angeles, CA

Peyman Benharash, MD
Division of Cardiac Surgery
Department of Surgery
University of California, Los Angeles
Los Angeles, CA

Yalda Afshar, MD, PhD
Division of Maternal Fetal Medicine
Department of Obstetrics and Gynecology
David Geffen School of Medicine at University of California, Los Angeles

200 Medical Plaza, Ste. 430
OBJECTIVE: The Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Fetal Growth Studies—Singletons developed fetal growth standards in a contemporary, race and ethnicity diverse, and healthy multisite population in the United States.1 The study revealed differences in fetal growth, represented as size-for-gestational-age, by maternal self-reported race and ethnicity, demonstrable as early as 10 to 16 weeks’ gestation.2,3 Based on these findings, fetal growth standards stratified by race and ethnicity were developed because pooling results among self-identified racial and ethnic groups may differentially classify growth at the extremes, namely small for gestational age (SGA) or large for gestational age (LGA).4,5 For example, the study-derived fetal growth standard, including all racial and ethnic groups, then a unified standard based solely on the White racial and ethnic group classification of fourth (SGA) or fifth (LGA) percentiles.2,3 Since that time, there has been recognition that inclusion of self-reported race and ethnicity in clinical algorithms may create unintended consequences for diagnosis and intervention.6,7 In addition, if an individual does not identify as one of the specified racial and ethnic groups, then a unified standard may be more useful as a first step in the diagnostic process. We sought to create a contemporary, unified fetal growth standard, including all healthy participants in the NICHD Fetal Growth Studies—Singletons, weighted to represent the US population of pregnant women, to supplement our previous work and compare with (1) our previous racial-and ethnic-specific standards3 and (2) the Hadlock reference8 because the Society for Maternal-Fetal Medicine (SMFM) recommends the use of “population-based fetal growth references (such as Hadlock).”9

STUDY DESIGN: Analyses included the same sample used for the racial- and ethnic-specific standards,1 composed of 1737 pregnant individuals without obesity with low-risk antenatal profiles from 12 US clinical sites (2009–2013) who delivered at ≥37 weeks’ gestation.10 Statistical analysis included 1732 eligible women (99.7%) with ultrasound measurements, of which 27.7%, 24.4%, 28.1%, and 19.8% self-identified as non-Hispanic White (NHW), non-Hispanic Black (NHB), Hispanic, and Asian or Pacific Islander (Asian), respectively. To approximate a nationally representative standard, the study sample was weighted back to a US population distribution of pregnant women using the natality statistics from 2011, which was the midpoint of the enrollment years (Supplement).10 Human subjects’ approval was obtained from all participating sites, and all women provided informed consent. A total of 6 research ultrasounds were performed measuring fetal biparietal diameter, head circumference (HC), abdominal circumference (AC), humerus, and femur length (FL). EFW was calculated from HC, AC and FL.11 The individual measurements, HC-to-AC ratio, and EFW were log-transformed to stabilize variances across gestational ages and improve normal approximations for error structures. Linear mixed models with cubic splines for the fixed and random effects were used to flexibly model fetal growth trajectories.12 Models were weighted on race and ethnicity.
Case 1

- **Intubation**
- **Cesarean Delivery 31w6d**
- **Off ECMO, Extubated**
- **ECMO 30w5d**
- **Max ECMO Uterine contractions HELLP vs. Abruption**
- **DIC, AKI**
- **Acute generalized exanthematous pustulosis**
- **Tracheostomy**
- **Out of ICU**
- **Discharge**

Days from Hospital Admission:

0 5 10 15 20 25 30 35 40 45 50 60 70 80

Case 2

- **Intubation ECMO Max ECMO**
- **Femoral DVT Pulmonary Embolism**
- **Off ECMO**
- **Out of ICU**
- **Cesarean Delivery 26w5d**
- **Extubated**
- **Pseudomonas pneumonia**
- **Discharge**

Days from Hospital Admission:

0 5 10 15 20 25 30 35 40 45 50 60 70 80

AKI, acute kidney failure; DIC, disseminated intravascular coagulation; DVT, deep vein thrombosis; ECMO, extracorporeal membrane oxygenation; ESBL, extended spectrum beta lactamase; GA, gestational age; GI, gastrointestinal tract; HELLP, hemolysis, elevated liver enzymes, low platelets syndrome; ICU, intensive care unit; IVC, inferior vena cava; RIJ, right internal jugular; UTI, urinary tract infection; VTE, venous thromboembolism.

Yin. Extracorporeal membrane oxygenation in pregnancy for severe respiratory failure in COVID-19. Am J Obstet Gynecol 2022.
SUPPLEMENTAL FIGURE

Case 3

0 703015 45 60 35 40 50 20 25 51 0
Days from Hospital Admission

ECMO 24w6d
Intubation
+RJ Cannula
ESBL Ecoli UTI
Thrombocytopenia 42 e/uL
Max ECMO
Weaning ECMO Decision to Deliver
HELLP improved, retrospective diagnosis
Extubated, Tracheostomy
Delayed PPH x 2
Out of ICU
Discharge
Cesarean Delivery 29w3d

Case 4

0 703015 45 60 35 40 50 20 25 51 0
Days from Hospital Admission

ECMO 25w1d
Intubation
Pneumothorax
Pseudomonas Pneumonia
Tracheostomy
Atrial fibrillation, cardioversion
Cesarean Delivery 29w2d
Rectus hematoma: abdominal washout, inferior epigastric embolization
Enterobacter Pneumonia
Pneumothorax
Progestin for vaginal bleeding
Max ECMO
Cardiac arrest
IR Hemoperitoneum drainage
Lower GI bleed
Femoral DVT
Off ECMO, Extubated
Out of ICU
Discharge
Remove Tracheostomy

Case 5

0 703015 45 60 35 40 50 20 25 51 0
Days from Hospital Admission

ECMO 25w6d
Intubation
Max ECMO
Gastrocnemius DVT
Extubated
Thrombocytopenia
Discharge Ongoing Pregnancy 28w2d
Out of ICU

Yin. Extracorporeal membrane oxygenation in pregnancy for severe respiratory failure in COVID-19. Am J Obstet Gynecol 2022.

576.e2 American Journal of Obstetrics & Gynecology APRIL 2022
ECMO in Pregnancy for Severe COVID-19

Case Series at a Single Academic Hospital: N = 5

ECMO Time before delivery
10 days (1-32)

Survival to discharge
100%

ECMO Time total
11 days (10-68)

Complications
- Mood Disorder 75%
- Transfusion 80%
- Pressor 80%
- VTE 80%
- Infection 80%

Median GA at birth
29 Weeks

Survival to discharge 100%

Yin. Extracorporeal membrane oxygenation in pregnancy for severe respiratory failure in COVID-19. Am J Obstet Gynecol 2022.
### SUPPLEMENTAL TABLE
Institutional protocols for management of COVID-19 and extracorporeal membrane oxygenation in pregnancy

| COVID-19 treatment                                      | Median (range) or N % | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|--------------------------------------------------------|-----------------------|--------|--------|--------|--------|--------|
| Remdesivir                                             | 4 80%                 | Yes    | Yes    | Yes    | Yes    | No     |
| Dexamethasone                                          | 5 100%                | Yes    | Yes    | Yes    | Yes    | Yes    |
| Antibiotics (ceftriaxone, azithromycin)                | 5 100%                | Yes    | Yes    | Yes    | Yes    | Yes    |
| Convalescent plasma                                    | 3 60%                 | Yes    | Yes    | No     | Yes    | No     |
| Monoclonal antibodies                                  | 2 40%                 | Tocilizumab | No    | No     | No     | No     |
| Anticytokines                                          | 0 0%                  | No     | No     | No     | No     | No     |
| Hydroxychloroquine                                     | 0 0%                  | No     | No     | No     | No     | No     |
| COVID-19 vaccination                                   | 0 0%                  | No     | No     | No     | No     | No     |
| Pulmonary vasodilator                                  | 2 40%                 | No     | No     | Yes    | Yes    | No     |
| Prone                                                  | 1 20%                 | Yes    | No     | No     | No     | No     |
| ECMO initiation                                         |                       |        |        |        |        |        |
| Arterial pH                                             | 7.35 (7.22–7.48)      | 7.38   | 7.31   | 7.22   | NA     | 7.48   |
| PaCO₂                                                  | 45 (31–50)            | 47     | 43     | 50     | NA     | 31     |
| PaO₂/FiO₂ ratio                                        | 94 (54–109)           | 94     | 68     | 54     | 95     | 109    |
| Murray score                                           | 3.5 (3.3–5)           | 3.5    | 4      | 3.8    | 3.3    | 3.5    |
| RESP score                                             | 5 (3–6)               | 3      | 5      | 4      | 6      | 6      |
| Echo ejection fraction                                 | 58% (55%–68%)         | 55%    | NA     | 77%    | 68%    | 58%    |
| Admit to ventilation (d)                               | 4 (2–5)               | 5      | 2      | 2      | 5      | 4      |
| Ventilation to ECMO (d)                                | 1 (0–2)               | 1      | 0      | 2      | 0      | 1      |
| Site (mobile)                                           | 4 80%                 | On site | Mobile | Mobile | Mobile | Mobile |
| Cannulation (femoral vein)                             | 5 100%                | 21 RFV, 25 LFV | 21 RFV, 25 LFV | 21 RFV, 25 LFV | 21 RFV, 25 LFV | 21 RFV, 25 LFV |
| Anticoagulation agent (addition to heparin)            | 3 60%                 | Heparin | Heparin | Heparin then argatroban | Heparin then argatroban | Heparin then argatroban |
| % time on therapeutic anticoagulation antepartum       | 100% (46–100%)        | 100%   | 100%   | 52%    | 46%    | 100%   |
| % time on therapeutic anticoagulation postpartum       | 86% (0–100%)          | 0%     | 100%   | 77%    | 95%    | —      |
| ECMO settings (maximum)                                 |                       |        |        |        |        |        |

Yin. Extracorporeal membrane oxygenation in pregnancy for severe respiratory failure in COVID-19. Am J Obstet Gynecol 2022. (continued)
### SUPPLEMENTAL TABLE

Institutional protocols for management of COVID-19 and extracorporeal membrane oxygenation in pregnancy (continued)

| COVID-19 treatment        | Median (range) or N % | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|---------------------------|-----------------------|--------|--------|--------|--------|--------|
| Pump flow (L/min)         | 4.2 (3.8–4.99)        | 4.2    | 3.85   | 6      | 3.8    | 4.99   |
| Pump speed (rotations/min)| 2810 (2260–3200)      | 2350   | 2260   | 3200   | 2850   | 2810   |
| Cardiac index (L/min/m²)  | 2.15 (1.99–2.91)      | 2.15   | 2.06   | 2.91   | 1.99   | 2.57   |
| FiO₂ (%)                  | 100 (70–100)          | 70     | 100    | 100    | 100    | 100    |
| Sweep (L/min)             | 6 (4–15)              | 6      | 4      | 11     | 15     | 5      |

Fetal interventions

|                         |                      |       |       |       |       |       |
|-------------------------|----------------------|-------|-------|-------|-------|-------|
| Length since last steroids (for any reason) at delivery (d) | 0 | 0% | 3 | 0 | 0 | 0 |
| Magnesium               | 2 | 50% | Yes | No | No | Yes |
| % continuous monitoring | 29% (0–59%)          | 25%   | 33%  | 59%  | 0%   | —     |

Delivery interventions

|                           |                      |       |       |       |       |       |
|---------------------------|----------------------|-------|-------|-------|-------|-------|
| Hysterotomy (low transverse) | 75%                 | Low transverse | Inverted T | Low transverse | Low transverse | —     |
| Oxytocin (units)          | 30 (10–60)           | 60    | 30    | 10    | 30    | —     |
| Methylergonovine          | 1 25%                | No    | No    | 200 µg | No    | —     |
| Carprofrost               | 0 0%                 | No    | No    | No    | No    | —     |
| Misoprostol               | 2 50%                | No    | No    | 1000 µg | 800 µg | —     |
| Tranexamic acid           | 1 20%                | No    | No    | No    | No    | 1 g   |
| Mechanical balloon for hemorrhage | 1 25% | No | No | Balloon | No | —     |
| Surgical antibiotics      | 4 100%               | Piperacillin, tazobactam, vancomycin | Ceftriaxone, azithromycin | Cefazolin, metronidazole | Cefazolin | —     |

ECMO, extracorporeal membrane oxygenation; RESP score, Respiratory ECMO Survival Prediction Score.

Yin. Extracorporeal membrane oxygenation in pregnancy for severe respiratory failure in COVID-19. Am J Obstet Gynecol 2022.