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.

Strengths of this study included the timely nature of our findings as the COVID-19 pandemic ensues, death tolls reach record highs, and communities adopt methods of social distancing to flatten the disease curve. Our findings are applicable to the obstetrical population who, regardless of the COVID-19 pandemic, cannot safely avoid or delay contact with hospitals compared with other patient populations because pregnancy is finite. The limited number of patients in our study was a potential weakness. In addition, given that we only investigated obstetrical patients, our findings may not be generalizable to other populations within the medical community. In addition, our study is preliminary and ongoing; hence we do not have any data on pregnancy outcomes. Our results were similar to those reported in a Letter to the Editor in the *New England Journal of Medicine* published on April 13, 2020, reporting that 13.5% of patients during a 2-week time period in 1 institution were asymptomatic and positive for SARS-CoV-2[7]; this finding was very similar to the asymptomatic SARS-CoV-2–positive rate in our population of 13% (21/161).

Our results can be used as a guide to other L&D units in deciding whether all admitted obstetrical patients should be routinely tested for SARS-CoV-2, the virus responsible for COVID-19. ■

William S. Vintzileos, MD
Department of Obstetrics and Gynecology
NYU Winthrop Hospital
NYU Langone Health
NYU Long Island School of Medicine
259 1st Street
Mineola, NY
william.vintzileos@nyulangone.org

Jolene Muscat, MD
Eva Hoffmann, MD
Nicole S. John, MD
Rosanne Vertichio, MSN, RN
Anthony M. Vintzileos, MD
Department of Obstetrics and Gynecology
NYU Winthrop Hospital
NYU Langone Health
NYU Long Island School of Medicine
Mineola, NY

Duc Vo, MD
Department of Pathology
NYU Winthrop Hospital
NYU Langone Health
NYU Long Island School of Medicine
Mineola, NY

The authors report no conflict of interest.

This communication has been published in the middle of the COVID-19 pandemic and is available via expedited publication to assist patients and healthcare providers.

Click Video under article title in Contents at ajog.org

REFERENCES

1. Department of Health, New York. COVID-19 testing. 2020. Available at: https://coronavirus.health.ny.gov/covid-19-testing. Accessed April 9, 2020.

2. World Health Organization. Coronavirus disease 2019 (COVID-19). Situation Report 73. 2020. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200402-sitrep-73-covid-19.pdf?sfvrsn=5ae25bc7_2. Accessed April 9, 2020.

3. Centers for Disease Control and Prevention. COVID-19: strategies for optimizing the supply of PPE. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/index.html. Accessed April 9, 2020.

4. Society for Maternal Fetal Medicine. Coronavirus (COVID-19) and pregnancy: what maternal-fetal medicine subspecialists need to know. 2020. Available at: https://s3.amazonaws.com/cdn.smfm.org/media/2267/COVID19-_updated_3-17-20_PDF.pdf. Accessed April 9, 2020.

5. Centers for Disease Control and Prevention. Interim guidance: healthcare professionals. 2019. Published March 14, 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-criteria.html. Accessed April 9, 2020.

6. Cepheid. Xpert. Xpress SARS-CoV-2 has received FDA emergency use authorization. Available at: https://www.cepheid.com/coronavirus. Accessed April 9, 2020.

7. Sutton D, Fuchs K, D'Alton M, Goffman D. Universal screening for SARS-CoV-2 in women admitted for delivery. N Engl J Med 2020. NEJMc2009316 [Epub ahead of print].

 https://doi.org/10.1016/j.ajog.2020.04.024

Care of critically ill pregnant patients with coronavirus disease 2019: a case series

OBJECTIVE: The novel coronavirus disease 2019 (COVID-19), the outbreak of which has caused a global pandemic, is spreading rapidly throughout the United States, with major metropolitan areas such as Philadelphia, seeing a dramatic rise in infection rates. Although pregnant women are not affected more severely than nonpregnant patients,[1] a number of obstetrical patients will nevertheless require intensive care similar to their nonpregnant counterparts. Here, we review 5 critical cases of COVID-19[2] during pregnancy, as well as general management principles.

STUDY DESIGN: This was a retrospective, multicenter case series of symptomatic pregnant women who had a positive

TABLE
Maternal and clinical characteristics of critically ill pregnant patients with COVID-19

Characteristics	Case 1	Case 2	Case 3	Case 4	Case 5
Age (y)	29	33	39	27	35
Race/ethnicity	Asian	White	Hispanic	Black	White
BMI (kg/m^2)	24.6	27.8	42.5	34.7	32
Admission GA	31 wk 2 d	26 wk 0 d	28 wk 3 d	30 wk 3 d	25 wk 2 d
Chief complaint	Fever, dyspnea	Fever, cough, dyspnea	Fever, cough	Fever, cough, dyspnea	Fatigue, cough, rhinorrhea, headache, fever, dyspnea
Medical comorbidities	Chronic kidney disease (C1q nephropathy), hypertension (on ACE inhibitor before pregnancy)	Mild, intermittent asthma	Obesity, hypertension, insulin-dependent diabetes	Hypertension (no medication)	obesity
Notable admission laboratory results	Elevated creatinine (patient baseline)	None	Elevated CRP and lactic acid	Thrombocytopenia	Elevated amniotransferases
Number of days from symptom onset to intubation	9	10	14	7	9
Adjunctive therapy	HCQ, remdesivir	HCQ, remdesivir	HCQ, remdesivir	HCQ remdesivir	HCQ, remdesivir
Antenatal steroids and HD administered	Betamethasone, HD 3	Dexamethasone, HD 3, 4	Betamethasone, HD 7, 8	Betamethasone, HD 3, 4	Betamethasone, HD 1, 2
Additional clinical details	Intubated at 31 wk 4 d, extubation HD 16 with reintubation, final extubation HD 20, discharged HD 24	Intubated at 26 wk 1 d, prone ventilation (× 2), tracheostomy 29 wk 1 d, suspected inferior vena cava thrombus	Intubated at 28 wk 3 d, prone ventilation (× 1), extubated on HD 19	Intubated at 30 wk 5d, bacteremia, extubated HD 15, discharged HD 20	Intubated at 25 wk 2 d, extubation HD 6 with reintubation, final extubation HD 8, discharged HD 13
Delivery	Yes	No	Yes	Yes	No
Indication	Maternal		Maternal	Maternal	
GA at delivery	31 wk 4 d		30 wk 2 d	31 wk 3 d	
Mode	Cesarean		Cesarean	Cesarean	
Neonatal birthweight (g)	1500		2110	1845	
Apgar score	9, 9		8, 9	2, 4, 4	
Neonatal SARS-CoV-2 PCR result at 24 HOL	Negative		Negative	Negative	

ACE, angiotensin-converting-enzyme, *BMI*, body mass index; *COVID-19*, coronavirus disease 2019; *CRP*, c-reactive protein; *GA*, gestational age; *HCQ*, hydroxychloroquine; *HD*, hospital day; *HOL*, hours of life; *PCR*, polymerase chain reaction; *SARS-CoV-2*, severe acute respiratory syndrome coronavirus 2.

Hirshberg. Care of critically ill pregnant patients with COVID-19. Am J Obstet Gynecol 2020.

result for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing and required critical care.

RESULTS: The clinical courses of 5 pregnant women with severe cases of COVID-19 disease, all requiring mechanical ventilation, are described below and summarized in the Table. Testing for the presence of SARS-CoV-2 was done through a reverse transcription polymerase chain reaction test of a nasopharyngeal swab unless otherwise specified.

Case 1 involved a 28-year-old G1P0 with chronic kidney disease and hypertension. She developed worsening dyspnea on the sixth day of outpatient monitoring after a confirmed diagnosis of COVID-19. She presented to the hospital with fever and dyspnea at 31 weeks of gestation. Chest imaging

showed multifocal pneumonia, and she required O_2 at a flow rate of 2 L/min to maintain her oxygen saturation levels above 95%. On hospital day (HD) 3, her oxygen saturation dropped to 80%, and she required additional O_2 at a flow rate of 6 L/min. Antenatal corticosteroids were administered, and based on a concern for further decompensation, the decision was made to proceed with intubation and delivery under controlled settings. She had an uncomplicated cesarean delivery and recovered from acute respiratory distress syndrome (ARDS) in the intensive care unit (ICU). She completed courses of hydroxychloroquine and remdesivir and was ultimately extubated on postoperative day 17 after gradual weaning. She was discharged 4 days later after 2 consecutive negative SARS-CoV-2 test results.

Case 2 involved a 33-year-old G6P5005 with mild asthma who presented, at 26 weeks of gestation, with worsening fevers and respiratory symptoms for 10 days. Her O_2 saturation level was 83%, and she required O_2 at a flow rate of 5 L/min. Chest imaging revealed multifocal pneumonia. Testing for SARS-CoV-2 delivered a positive result. She was transferred to the ICU with an increasing demand for oxygen supplementation, and she was intubated several hours later. Based on the early gestational age and maternal acuity, continuous fetal heart monitoring was not initiated. Administration of antenatal corticosteroids was deferred owing to a concern for worsening viral shedding. Her course has been complicated by ARDS, septic shock, and inferior vena cava thrombus treated with anticoagulants. She had completed courses of hydroxychloroquine and remdesivir, as well as antibiotic courses for superimposed bacterial pneumonia. She also required vasopressor support and stress dose steroids for sepsis (using dexamethasone for adjunctive fetal benefit). She was placed in the prone position for worsening hypoxemic respiratory failure and acidosis on HD 3 and 8, with improvement, and a cannula was put in place for the treatment of extracorporeal membrane oxygenation (ECMO) in the case of further deterioration. She remains critically ill, although ventilation support has been reduced to a tracheostomy collar. Daily fetal heart tone checks in conjunction with intermittent biophysical profiles, have delivered positive results to date. Delivery is being considered, but the significant improvements in maternal health and early gestational age warrant deferral.

Case 3 involved a 39-year-old G4P3003 with hypertension, obstructive sleep apnea, and insulin-dependent diabetes who presented, at 28 weeks' gestation, with a persistent fever that had been present for 2 weeks, a cough, and worsening dyspnea. She was febrile, tachypneic, and hypoxic (with an O_2 saturation level of 86%) on arrival, had a positive result for SARS-CoV-2 testing, and displayed multifocal pneumonia based on chest imaging. She was transferred to the ICU for worsening dyspnea, where she was intubated and subsequently transferred to our tertiary care facility for ARDS. She was treated with antibiotics for superimposed bacterial pneumonia and received hydroxychloroquine, remdesivir, and anticoagulation therapy. She was placed in the prone position on HD 7 for worsening hypoxemic respiratory failure, at which point antenatal corticosteroids were administered. The results of fetal evaluation through daily heart tone checks were normal. She underwent an uncomplicated repeat cesarean delivery on HD 15, at 30 weeks and 2 days' gestation, under controlled mechanical ventilation for persistent, but stable, critical illness. She was extubated on postoperative day 5 (HD 20) and transitioned to a high-flow nasal cannula.

Case 4 involved a 27-year-old G3P0202 who presented, at 30 weeks of gestation, with 4 days of myalgias, fatigue, a productive cough, and fever. She was tachycardic (with a heart rate greater than 130 beats/min) on arrival, and chest imaging revealed multifocal pneumonia. A test for SARS-CoV-2 was positive. She began receiving hydroxychloroquine and was transferred to the ICU for impending respiratory failure. She was intubated 2 days later, at which time she also received betamethasone and started receiving a course of remdesivir. The results of daily fetal heart tone monitoring were normal. Her blood cultures were positive for *Proteus mirabilis*, and she was subsequently treated with broad spectrum antibiotics for superimposed pneumonia. Attempts to wean her from supporting ventilation were unsuccessful, and arterial blood gas revealed persistent acidemia. She underwent an uncomplicated primary cesarean delivery on HD 9 because of her declining respiratory status. She was extubated on HD 15 and discharged after being on room air for 5 days.

Case 5 involved a 35-year-old G4P2012 who presented, at 25 weeks' gestation, with 9 days of fever, cough, and progressive dyspnea. She was febrile and tachypneic, with chest imaging demonstrating multifocal pneumonia. She was admitted for suspected COVID-19—related pneumonia, treated with hydroxychloroquine and antibiotics, and transferred to the ICU for impending respiratory failure and intubation. The results of 2 initial SARS-CoV-2 tests were negative, although she remained critically ill and required vasopressor support. Empirical oseltamivir therapy was initiated, and owing to an increasing probability of delivery, antenatal corticosteroids were administered. A third inpatient SARS-CoV-2 test (from tracheal aspirate) delivered a positive result, and remdesivir was started. She was successfully extubated on HD 8, weaned to room air on HD 11, and discharged 2 days later with close outpatient follow-ups.

CONCLUSION: The number of pregnant patients requiring critical care thus far appears to be higher in Philadelphia hospitals than in other published accounts. A report, from Singapore, that was published during the early stages of the pandemic, chronicled a total of 55 published cases of pregnant patients with COVID-19 disease, with no reports of mortality and only 1 report of a requirement for mechanical ventilation.[3] Other reviews have uncovered only 3 additional cases of critical illness linked to COVID-19 during pregnancy.[4,5] The early American experience with COVID-19 in pregnancy was characterized by a case

series from New York that reported on a total of 2 critical cases, both postpartum.[1]

Although most patients, including pregnant women, can be managed on an outpatient basis, our experience suggests that obstetrical patients with a diagnosis of COVID-19, both with and without comorbidities, can have severe disease symptoms in the antepartum period. Potential worsening of respiratory symptoms up to 14 days after onset can occur in pregnant women, as evidenced by the intubation timing ranging from 7 to 14 days from the onset of symptoms in our cases.

Critical care management of obstetrical patients with COVID-19 should generally be guided by the same principles as for the nonpregnant adult population and is contingent on effective multidisciplinary care. The National Institutes of Health published updated treatment guidelines for COVID-19, including special considerations for pregnant women.[6] Important considerations include early detection of severe illness and individualized decisions regarding the use of adjunctive medications because pregnant women are not included in many of the current clinical trials that are exploring treatment options for COVID-19. Various oxygen delivery methods, including the use of high-flow nasal cannulas, noninvasive positive-pressure ventilation, and endotracheal intubation, can all be used safely in pregnancy. Prone ventilation, although technically challenging in later pregnancy, can be implemented with appropriate support for the gravid abdomen, even in the third trimester. Venovenous ECMO has been used in nonpregnant adults with COVID-19 to support respiration. Although it was not used in our cases, ECMO has been used in pregnancy to support oxygenation for H1N1 influenza and patients with refractory ARDS and should be considered as an alternative rescue strategy for COVID-19. With recent data suggesting a high incidence of thrombotic complications in ICU patients with COVID-19 infection, and the known hypercoagulable state of pregnancy, the use of high-dose prophylactic and therapeutic anticoagulation treatment should also be strongly considered in critically ill pregnant patients.

Unique complications that are limited to pregnant patients include decisions about fetal monitoring, administration of antenatal corticosteroids, and delivery, all of which should be individualized because data guiding specific management strategies in this particular disease are lacking. Nonetheless, fetal monitoring in pregnant patients with COVID-19 should follow the same considerations as in other critical illness and delivery should be considered only after fetal viability, when delivery would not compromise maternal health, or as a noninvasive measure of maternal status. Although prolonged exposure to high-dose corticosteroids is theoretically associated with adverse patient outcomes from COVID-19 based on early reports, corticosteroid courses for fetal lung maturity are short and should only be administered if the probability of early preterm delivery is high. For intubated pregnant patients with COVID-19, the timing of delivery must balance the maternal and neonatal risk and benefit, with delivery being considered as a potential tool to improve ventilation owing to the physiological changes associated with pregnancy.

At present, limited data are available on critically ill pregnant women with COVID-19, as evidenced by varying management of our 5 cases. Clinical recommendations will surely continue to evolve as we learn more about this disease in pregnant and nonpregnant adults. As the pandemic unfolds and more microbiologic, pharmacologic, and clinical information about COVID-19 comes to light, it remains important to consider the unique needs of critically ill pregnant patients when formulating specific guidelines and treatment plans. ■

Adi Hirshberg, MD
Adina R. Kern-Goldberger, MD, MPH
Lisa D. Levine, MD, MSCE
Department of Obstetrics & Gynecology
Maternal Child Health Research Center
University of Pennsylvania Perelman School of Medicine
Philadelphia, PA
Adi.Hirshberg@pennmedicine.upenn.edu

Rebecca Pierce-Williams, DO
Division of Maternal-Fetal Medicine
Department of Obstetrics and Gynecology
Sidney Kimmel Medical College of Thomas Jefferson University
Philadelphia, PA

William R. Short, MD, MPH
Division of Infectious Diseases
Department of Internal Medicine
Hospital of the University of Pennsylvania
Philadelphia, PA

Samuel Parry, MD
Department of Obstetrics & Gynecology
Maternal Child Health Research Center
University of Pennsylvania Perelman School of Medicine
Philadelphia, PA

Vincenzo Berghella, MD
Division of Maternal-Fetal Medicine
Department of Obstetrics and Gynecology
Sidney Kimmel Medical College of Thomas Jefferson University
Philadelphia, PA

Jourdan E. Triebwasser, MD, MA
Sindhu K. Srinivas, MD, MSCE
Department of Obstetrics & Gynecology
Maternal Child Health Research Center
University of Pennsylvania Perelman School of Medicine
Philadelphia, PA

This communication has been published in the middle of the COVID-19 pandemic and is available via expedited publication to assist patients and healthcare providers.

The authors report no conflict of interest.

REFERENCES

1. Breslin N, BC, Baptiste C, Gyamfi-Bannerman C, et al. COVID-19 infection among asymptomatic and symptomatic pregnant women:

two weeks of confirmed presentations to an affiliated pair of New York City hospitals. Am J Obstet Gynecol MFM 2020. [Epub ahead of print].
2. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. JAMA 2020. [Epub ahead of print].
3. Dashraath P, Wong JLJ, Lim MXK, et al. Coronavirus disease 2019 (COVID-19) pandemic and pregnancy. Am J Obstet Gynecol 2020. [Epub ahead of print].
4. Mullins E, Evans D, Viner RM, O'Brien P, Morris E. Coronavirus in pregnancy and delivery: rapid review. Ultrasound Obstet Gynecol 2020. [Epub ahead of print].
5. Zaigham M, Andersson O. Maternal and perinatal outcomes with COVID-19: a systematic review of 108 pregnancies. Acta Obstet Gynecol Scand 2020. [Epub ahead of print].
6. NIH. COVID-19 treatment guidelines. Available at: https://covid19treatmentguidelines.nih.gov/introduction/. Accessed April 23, 2020.

 https://doi.org/10.1016/j.ajog.2020.04.029

Intensive care unit admissions for pregnant and nonpregnant women with coronavirus disease 2019

Check for updates

OBJECTIVE: Early reports indicate that pregnant women are not at an increased risk for coronavirus disease 2019 (COVID-19) or for a worse disease course if infection occurs.[1-3] This study aimed to review our experiences with intensive care unit (ICU) admissions of women of reproductive age with COVID-19, and to determine whether pregnant women are more likely to be admitted to the ICU than nonpregnant women.

STUDY DESIGN: We evaluated data from a large hospital system in New York State between March 2, 2020, and April 9, 2020. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing was performed on acutely symptomatic patients presenting with characteristic respiratory signs and symptoms.[4] Nasopharyngeal specimens were obtained, and microbiologic diagnosis was made on the basis of a positive result on SARS-CoV-2 real-time reverse transcription polymerase chain reaction (RT-PCR) assay. We included only patients of reproductive age (15–49 years) who were admitted to 1 of 7 hospitals in our system and who received a diagnosis of COVID-19 by RT-PCR on admission, during the hospital stay, or during the postpartum period. Data analyzed in this study included age (5 age groups between 15 and 49 years), pregnancy status, and admission to an ICU. We excluded patients with incomplete data. The incidence of ICU admission was compared between pregnant and nonpregnant women with COVID-19 in each age group. Patients were admitted to the ICU at the discretion of the consulted critical care attending physician. Other clinical characteristics, including medical comorbidities, were not evaluated and not necessarily the same. The institutional review board determined that this study did not meet the definition of human subjects research and was exempt from formal review.

RESULTS: Among all patients between the ages of 15–49 years admitted at 7 hospitals within our health system between March 4, 2020, and April 9, 2020, there were 1168 symptomatic patients who received a diagnosis of COVID-19. Of these, 754 (64.6%) were male, 332 (28.4%) were nonpregnant females, and 82 (7.0%) were pregnant females. During this time period, 2971 pregnant patients were admitted, primarily

TABLE
ICU admissions by age group in pregnant and nonpregnant women with COVID-19

Age group, y	Pregnant women (n = 82)	Nonpregnant women (n = 332)	*P* value
<25	1/11 (9.1)	3/7 (42.9)	.09
25–29	0/17 (0)	5/40 (12.5)	.16
30–34	2/33 (6.1)	5/44 (11.4)	.46
35–39	3/15 (20.0)	9/55 (16.4)	.73
40–49	2/6 (33.3)	28/190 (14.7)	.28
Total	8/82 (9.8)	50/332 (15.1)	.22

Values are presented as n/N (%).

COVID-19, coronavirus disease 2019; *ICU*, intensive care unit.

Blitz. ICU admissions for pregnant and nonpregnant women with COVID-19. Am J Obstet Gynecol 2020.