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Timing of delivery with coronavirus disease 2019 pneumonia requiring intensive care unit admission



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Approximately 4% of pregnant patients with coronavirus disease 2019 require intensive care unit admission. Given the practical implications of advanced ventilatory and circulatory support techniques, urgent or emergent delivery for nonreassuring fetal status frequently presents a logistical impossibility. This article proposes a protocol for obstetrical management

of patients in these situations, emphasizing coordinated preparation among obstetrical, anesthesiology, and intensivist teams for planned preterm delivery at gestational ages when neonatal outcomes are likely to be favorable.

A 25-year-old G2P1001 at 30+2/7 weeks' gestation is admitted to the intensive care unit (ICU) because of coronavirus disease 2019 (COVID-19) pneumonia with hypoxemia. Although she remains hemodynamically stable, attempts at noninvasive ventilation and prone positioning led to minimal improvements in maternal oxygenation. At this time, the fetal heart rate tracing begins to demonstrate repetitive late decelerations with minimal variability. What is the most appropriate obstetrical course of action?

Decisions regarding the delivery timing of critically-ill pregnant patients with COVID-19 present a challenging obstetrical juxtaposition: balancing a consultative role on the critical care team with respect to obstetrical concerns while simultaneously assuming the primary responsibility for evaluation and management of the fetal status. Inevitably, the role of fetal monitoring and specific indications for delivery arise whenever a pregnant patient at a viable gestational age is admitted to the ICU. This article intends to review the contemporary evidence regarding the pregnant COVID-19 patient requiring intensive care owing to a requirement for escalating oxygen therapy and proposes explicit guidance regarding delivery timing.

Introduction

Approximately 13% of pregnant patients who contract COVID-19 present or progress to a severe disease status, with 4% of those requiring ICU admission (Table).¹⁻⁴ The Centers for Disease Control and Prevention has suggested that pregnancy confers a higher risk for requiring either mechanical ventilation or extracorporeal membrane oxygenation (ECMO); overall, mortality appears to be increased, and limited contemporary data have suggested a higher rate of intrauterine fetal demise.^{5,6} Fortunately, the majority of pregnant patients with COVID-19 infection experience mild symptomatology and do not require hospitalization, and many of these patients do not come to the attention of health-care providers beyond reporting positive test results, confirmation of a stable clinical status, and recommendation for self-quarantine.³ However, for patients who do require supplemental O₂, mechanical ventilation, or ECMO, there is growing recognition that recovery and eventual extubation (and/or decannulation) is commonly a very protracted process.⁷ Thus, the obstetrician may be confronted with a situation in which delivery either may be performed electively in a controlled manner before escalation (or expected escalation) of therapy or cannot be permitted until maternal cardiopulmonary stability has been reached because of inherent practical limitations.

Existing Evidence

Maternal

Most of the contemporary literature regarding obstetrical COVID-19 cases falls into the realm of either epidemiologic reports describing maternal and neonatal outcomes or case reports describing management in a variety of clinical circumstances.^{8,9} Preliminary data from China suggest that preterm delivery by cesarean delivery was almost 3-fold more common among patients with COVID-19, although specific distinction between indicated or spontaneous subcategories was not reported.¹⁰ A subsequent meta-analysis has shown an overall preterm delivery rate of approximately 29%, whereas

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TABLE

Criteria for severe or critical coronavirus disease 2019 cases

Parameter	NIH ¹	Wu ²
Pulmonary	Severe	Severe
	Respiratory rate >30/min	Respiratory rate >30/min
	SpO ₂ <94% on room air	SpO ₂ <93% on room air
	PaO ₂ or FiO ₂ <300	PaO ₂ or FiO ₂ <300
	Lung infiltrates >50%	Lung infiltrates >50%
	Critical	Critical
	Respiratory failure (mechanical ventilation)	Respiratory failure (mechanical ventilation)
Circulatory	Septic shock	Shock
Other	Multiorgan dysfunction	Multiorgan dysfunction

FiO₂, fraction of inspired O₂; NIH, National Institutes of Health; PaO₂, partial pressure of O₂; SpO₂, O₂ saturation.

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another group found a cesarean delivery rate of 89%.^{11,12} Early data from the United States demonstrated a lower but overall increased (15%) incidence of preterm delivery with a concomitant increase in cesarean delivery rate (38%), whereas more recent reviews focusing exclusively on the critically-ill population have found an 88% rate of preterm delivery with 94% of these occurring by cesarean delivery.^{6,13} An expert consensus panel has recommended delivery for patients with severe disease status at ≥ 32 to 34 weeks' gestation owing to the anticipated high likelihood of intact neonatal survival.^{14,15}

Neonatal

Outcomes of neonates born to mothers with COVID-19 are primarily dependent on the gestational age at birth.¹⁶ Although isolated reports have described rare individual cases of vertical transmission, the overall incidence of postnatal infection is reported to fall in the range of 3% to 5%; given the relatively recent onset of the pandemic, long-term data are not yet available.^{17–19} Most neonatal complications arise because of iatrogenic prematurity instead of the infection itself.

The Case for Indicated Preterm Delivery

Pregnant patients admitted to the ICU constitute a relatively unique population in that both the maternal and fetal status must simultaneously be taken into account. Guidelines for management are primarily derived from clinical experience—not clinical trials—and tend to focus on treatment of the maternal condition, with only general recommendations regarding fetal assessment and indications for delivery.²⁰ With respect to COVID-19 pneumonia, the principles of care are most similar to those of patients with acute respiratory distress syndrome with modifications in the medication regimens, target laboratory and physiological parameters, and maternal positioning.²¹ Decisions regarding the frequency of fetal monitoring and/or delivery are governed by the maternal

status and gestational age, with the fetal cardiocotocograph proposed to represent an additional “vital sign” to both guide and determine the efficacy of therapy.²²

Criteria for refractory maternal hypoxemia generally include a partial pressure of O₂ (PaO₂) of <60 mm Hg while receiving a fraction of inspired O₂ (FiO₂) of 1.0, however, on a clinical basis, this definition can be expanded to include severe hypoxemia (PaO₂ to FiO₂ ratio of <150) unresponsive to incremental increases in positive end expiratory pressure (PEEP), recruitment of lung volumes, prone positioning, and/or deep sedation with chemical paralysis.²³ Advanced therapies such as pulmonary vasodilator medications or venovenous (V-V) ECMO are often considered in these situations, however, complications of hemorrhage requiring transfusion (57%–67%) and infection (58%) are frequent with ECMO, and the requirement for continuous anticoagulation therapy introduces a further complicating factor in the event of an unplanned delivery.^{24–26}

When a pregnant patient with COVID-19 pneumonia is admitted to the ICU, parameters for urgent delivery should be established and a contingency plan communicated to all involved teams. Often there are substantial practical impediments involved in rapidly moving a critically-ill patient from the ICU to a delivery suite or operating room, particularly if located in geographically separate areas of a hospital; consequently, the ability to respond to a nonreassuring fetal heart rate pattern by performing an “emergent” cesarean delivery in the conventional obstetrical manner may become a logistical impossibility. Moreover, the actual process of transporting a patient with COVID-19 leads to exposure of additional personnel to a risk of infection. Proceeding with delivery in the ICU presents an alternative solution, however, this also may present attendant difficulties owing to the unfamiliarity of the surgical staff to an unconventional setting that can affect their ability to expediently and efficiently manage intraoperative complications (ie, postpartum hemorrhage). At the primary author's

institution, this option would generally be reserved for cases involving perimortem or resuscitative cesarean deliveries.

It should be emphasized that admission to the ICU for COVID-19 pneumonia does not constitute an intrinsic indication for delivery per se. For clinically stable patients at gestational ages of 23 or 24 to 32 weeks' gestation, continuation of the pregnancy with intermittent monitoring of the fetal heart rate represents the preferred approach. If possible, the patient or responsible family members should be engaged to ascertain their preferences for delivery and neonatal resuscitation; a neonatology consultation may be advantageous for counseling. If refractory maternal hypoxemia leads to a non-reassuring fetal status, maternal interventions should be trialed for a defined interval, balancing the risk of potential neonatal acidosis with that of an (indicated) iatrogenic premature delivery.

To preclude such a scenario, given the anticipated favorable neonatal outcomes, the authors would suggest that in pregnant patients requiring advanced oxygen delivery modalities (mechanical ventilation with PEEP of ≥ 10 cm H₂O or V-V ECMO), elective delivery should be considered at gestational ages of 32+0/7 to 33+6/7 weeks, particularly if a course of antenatal corticosteroids has been completed. If a patient stabilizes with escalated O₂ therapy, delivery should be considered once a course of antenatal corticosteroids has been administered; however, if maternal oxygenation does not improve with escalating support, expedient delivery—irrespective of completion of an antenatal corticosteroid course—is recommended. This would be similarly applicable to patients at gestational ages of $\geq 34+0/7$ weeks; although a course of antenatal corticosteroids may be administered if gestational age is 34plus;0/7-36plus;6/7 weeks, delivery should be considered once the maternal status is optimized.

The method of delivery can be individualized based on the maternal clinical status, fetal condition, and obstetrical history. Successful induction of labor for mechanically-ventilated patients with COVID-19 has been described, however, a non-reassuring fetal status has been reported intrapartum in 34% of pregnancies in an early systematic review. Consequently, for coordination of the necessary resources and personnel availability, a cesarean delivery may represent the most pragmatic option.^{27,28} Interestingly, a single case report described marked pulmonary improvement following a cesarean delivery in a patient with COVID-19 at 30+5/7 weeks' gestation, suggesting that mechanical relief of the reduction in functional residual capacity and residual volume imposed by the gravid uterus may confer a therapeutic benefit; this may also be true with concurrent maternal respiratory conditions such as asthma and/or obesity, which alter lung volumes.²⁹ Postpartum improvement in hepatic disease has also been reported.³⁰ However, objective maternal benefit following delivery remains largely conjectural at this time, and is likely to remain so secondary to the inability to conduct clinical trials in this specific population.

The primary risks of elective preterm delivery include iatrogenic prematurity in the neonate and subjecting a critically-

ill, hypoxemic patient to further labor and/or surgical stress in the context of an uncertain prognosis. As noted, inherently, most deliveries in these circumstances are by cesarean delivery, and at the current time, there is no evidence that the route of delivery adversely influences the maternal prognosis.

Recommendations

Accordingly, based on the authors' combined institutional experiences, we propose the following general guidelines for pregnant patients requiring ICU admission for COVID-19 pneumonia (Figure):

At time of ICU admission:

- Obtain group B streptococcal culture if antibiotics have not been started previously.
- Start on prophylactic anticoagulation therapy with unfractionated heparin.³¹
- Administer remdesivir, dexamethasone, and/or other FDA-approved therapeutics according to institutional protocols; if dexamethasone is elected, a combination protocol of 48 hours of dexamethasone (6 mg intramuscular every 12 hours over 4 doses) followed by methylprednisolone (32 mg daily in single or divided doses) to complete a 10-day course would limit fetal corticosteroid exposure.³²
- Perform an obstetrical ultrasound to confirm fetal viability and gestational age in previable cases; evaluate gestational age, fetal presentation, estimated fetal weight, and amniotic fluid volume in viable cases.

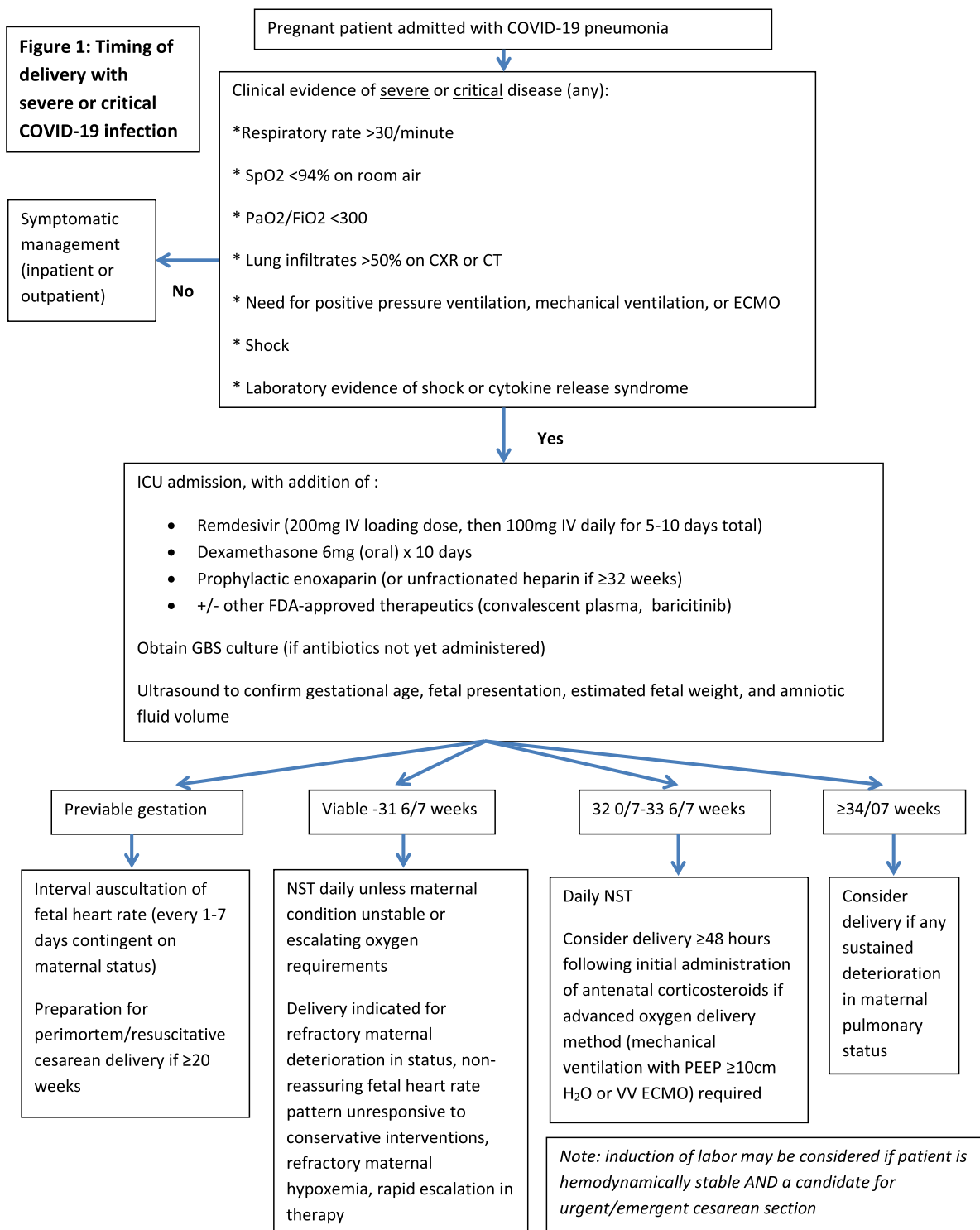
If gestational age is <23+0/7 to 24+0/7 weeks (previable):

- Perform interval auscultation of the fetal heart rate (every 1 to 7 days, contingent on provider preference), with a repeat assessment if the maternal clinical status deteriorates.
- Delivery at these previable gestational ages would only be indicated in the event of maternal cardiopulmonary arrest at a gestational age of ≥ 20 weeks (resuscitative cesarean delivery).

If gestational age is between 23+0/7 to 24+0/7 and 31+6/7 weeks:

- Administer an initial course of antenatal corticosteroids; a repeat course may be given if ≥ 7 days have elapsed and delivery in the next 7 days is deemed probable.³³
- Perform daily fetal assessments in the setting of a stable maternal clinical status and O₂ requirement; convert to continuous fetal monitoring if the maternal condition becomes unstable.
- Complete surgical consent form for cesarean delivery before administration of sedation (if feasible).
- Brief multidisciplinary meeting (“huddle”) between ICU staff, obstetrics, anesthesiology, and neonatology to devise a strategy for management in the event of a non-reassuring fetal status.

FIGURE
Timing of delivery in severe or critical COVID-19 cases



This flowchart diagram denotes a guideline for the management and delivery of COVID-19 patients requiring intensive care unit admission based on gestational age.

COVID-19, coronavirus disease 2019; CXR, chest x-ray; ECMO, extracorporeal membrane oxygenation; FDA, US Food and Drug Administrator; FiO₂, fraction of inspired O₂; IV, intravenous; NST, non-stress test; PaO₂, partial pressure of O₂; PEEP, positive end expiratory pressure; SpO₂, O₂ saturation; V-V, veno-venous.

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- Delivery is suggested for:
- Nonreassuring fetal status in the setting of refractory hypoxemia despite optimization of all aspects of conventional and/or advanced therapies.

Note that interventions to improve fetal status may be attempted briefly, recognizing that a delay in proceeding with delivery could result in neonatal acidosis.

- If delivery is planned:
- Discontinue anticoagulation therapy 12 to 24 hours in advance.
- The safety of magnesium sulfate for eclampsia prophylaxis has been questioned vis-à-vis maternal respiratory depression; if utilized for fetal neuroprophylaxis in non-intubated patients, consideration may be given if the serum magnesium levels and fluid balance are monitored.^{15,34}
- Cognizant that the fetal status is inherently reflective of that of the mother, consider obtaining matched maternal arterial and fetal umbilical artery blood gas values at the time of delivery for comparative purposes.³⁵

If the gestational age is between 32+0/7 and 33+6/7 weeks:

- Administer a course of antenatal corticosteroids.
- Perform daily fetal assessments in the setting of a stable maternal clinical status and O₂ requirements; convert to continuous fetal monitoring if the maternal condition begins to deteriorate further (ie, increasing PEEP or FiO₂ to maintain PaO₂ at >70 mm Hg or O₂ saturation at >95%); it should be recognized that both the PEEP and FiO₂ needs can fluctuate throughout the COVID-19 disease process, and the increases in PEEP and FiO₂ in this context are intended to reflect persistent increases without substantial improvement in maternal oxygenation.
- Complete a surgical consent form for cesarean delivery before administration of sedation (if feasible).
- Brief multidisciplinary meeting (“huddle”) among ICU staff, obstetrics, anesthesiology, and neonatology to devise a strategy for management in the event of a non-reassuring fetal status.
- Delivery should be considered for:
- Nonreassuring fetal status in the setting of refractory maternal hypoxemia independent of corticosteroid completion.
- Requirement for mechanical ventilation with PEEP >10 cm H₂O or V-V ECMO, particularly if a course of antenatal corticosteroids has been completed.
- If delivery is planned:
- Discontinue anticoagulation therapy 12 to 24 hours in advance.

- Cognizant that the fetal status is inherently reflective of that of the mother, consider obtaining matched maternal arterial and fetal umbilical artery blood gas values at the time of delivery for comparative purposes.³⁵

If gestational age is $\geq 34+0/7$ weeks:

- Continuous fetal monitoring.
- Complete surgical consent form for cesarean delivery before administration of sedation (if feasible).
- A course of antenatal corticosteroids may be administered if gestational age is 34+0/7-36+6/7 weeks, but should not delay indicated preterm delivery.³⁶
- Brief multidisciplinary meeting (“huddle”) among ICU staff, obstetrics, anesthesiology, and neonatology with consideration of planned delivery following maternal stabilization.
- Delivery should be considered for:
- Any sustained deterioration in the maternal pulmonary status.
- Before delivery:
- Discontinue anticoagulation therapy 12 to 24 hours in advance.
- Cognizant that the fetal status is inherently reflective of that of the mother, consider obtaining matched maternal arterial and fetal umbilical artery blood gas values at the time of delivery for comparative purposes.³⁵

As the COVID-19 epidemic continues to besiege intensive care units nationwide, the authors recognize that this protocol is based primarily on the limited existing data and collective personal experience. The fundamental intent is to provide an initial blueprint for individual institutions to modify based on specific facilities, personnel, and circumstances and is anticipated to evolve with the introduction of new therapies. ■

Supplementary materials

Supplementary material associated with this article can be found in the online version, at doi:<https://doi.org/10.1016/j.ajogmf.2021.100373>.

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