Obstetric Anesthesia During the COVID-19 Pandemic

Melissa E. Bauer, DO,* Kyra Bernstein, MD,† Emily Dinges, MD,‡ Carlos Delgado, MD,‡ Nadir El-Sharawi, MD,§ Pervez Sultan, MD,‖ Jill M. Mhyre, MD,§ and Ruth Landau, MD†

With increasing numbers of coronavirus disease 2019 (COVID-19) cases due to efficient human-to-human transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the United States, preparation for the unpredictable setting of labor and delivery is paramount. The priorities are 2-fold in the management of obstetric patients with COVID-19 infection or persons under investigation (PUI): (1) caring for the range of asymptomatic to critically ill pregnant and postpartum women; (2) protecting health care workers and beyond from exposure during the delivery hospitalization (health care providers, personnel, family members). The goal of this review is to provide evidence-based recommendations or, when evidence is limited, expert opinion for anesthesiologists caring for pregnant women during the COVID-19 pandemic with a focus on preparedness and best clinical obstetric anesthesia practice. (Anesth Analg 2020;131:7–15)

GLOSSARY

ACE = angiotensin-converting enzyme; **ACOG** = American College of Obstetricians and Gynecologists; **AGP** = aerosol-generating procedure; **ARDS** = acute respiratory distress syndrome; **CD** = cesarean delivery; **COVID-19** = coronavirus disease 2019; **CSE** = combined spinal-epidural; **CT** = computed tomography; **F_{IO_2}** = fraction of inspired oxygen; **GA** = general anesthesia; **HEPA** = high-efficiency particulate air; **IgM** = immunoglobulin M; **IV** = intravenous; **NSAIDs** = nonsteroidal anti-inflammatory drugs; **OR** = operating room; **P_{aCO_2}** = partial pressure of carbon dioxide; **P_{aO_2}** = partial pressure of oxygen; **PCA** = patient-controlled analgesia; **PEEP** = positive end-expiratory pressure; **PDPH** = postdural puncture headache; **PONV** = postoperative nausea and vomiting; **PPE** = personal protective equipment; **PUI** = persons under investigation; **RANZCOG** = Royal Australian and New Zealand College of Obstetricians and Gynaecologists; **RCOA-OAA** = Royal College of Anaesthetists-Obstetric Anaesthetists' Association; **RCOG** = Royal College of Obstetricians and Gynaecologists; **RNA** = ribonucleic acid; **RT-PCR** = real-time reverse transcriptase–polymerase chain reaction; **SMFM-SOAP** = Society for Maternal-Fetal Medicine-Society for Obstetric Anesthesia and Perinatology; **SOAP** = Society for Obstetric Anesthesia and Perinatology; **SOGC** = Society of Obstetricians and Gynaecologists of Canada; **S_{pO_2}** = pulse oximetry; **SARS** = severe acute respiratory syndrome; **SARS-CoV-2** = severe acute respiratory syndrome coronavirus 2; **SPG** = sphenopalatine ganglion

The management of obstetric patients infected with coronavirus disease 2019 (COVID-19) due to human-to-human transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) requires quite unique considerations—from caring for critically ill pregnant and postpartum women to protecting health care workers from exposure during the delivery hospitalization (health care providers, personnel, family members, and beyond). The goal of this review is to provide evidence-based recommendations or, when evidence is limited, expert opinion for anesthesiologists caring for pregnant women during the COVID-19 pandemic with a focus on preparedness and best clinical obstetric anesthesia practice.

CLINICAL MANIFESTATION OF COVID-19 INFECTION IN PREGNANCY

Overall, the clinical characteristics in pregnant women with confirmed COVID-19 infection in China have been consistent with those reported among nonpregnant adults; better maternal and neonatal outcomes have been reported after COVID-19 infection compared with those associated with the 2002–2003 SARS-CoV-2 outbreak.[1–3]

The signs and symptoms of COVID-19 infection in a large data set in nonpregnant patients from China were fever (99%), fatigue (70%), cough (59%), shortness of breath (31%), myalgias (35%), headache (6.5%),

From the *Department of Anesthesiology, University of Michigan, Ann Arbor, Michigan; †Department of Anesthesiology, Columbia University College of Physicians and Surgeons, New York, New York; ‡Department of Anesthesiology & Pain Medicine, University of Washington, Seattle, Washington; §Department of Anesthesiology, University of Arkansas for Medical Sciences, Little Rock, Arkansas; and ‖Department of Anesthesia, Stanford University, Stanford, California.

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Address correspondence to Ruth Landau, MD, Department of Anesthesiology, Columbia University College of Physicians and Surgeons, New York, NY. Address e-mail to rl262@cumc.columbia.edu.

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sore throat (17%), diarrhea (10%), nausea (10%), and vomiting (4%).[4] An additional manifestation noted among patients with COVID-19 infection is the sudden loss (or reduction) of the sense of smell and taste, which is currently recommended by the American Academy of Otolaryngology-Head and Neck Surgery as part of screening for COVID-19 infection.[5]

In pregnancy, presentation of COVID-19 infection appears similar, but many of these nonspecific symptoms may be attributed to symptoms of pregnancy and labor.[2] For example, signs of latent labor may include myalgias and diarrhea; preeclampsia can present with headache; shortness of breath is perceived during pregnancy and labor; and chorioamnionitis may cause tachycardia and fever, thus, leading clinicians to overlook COVID-19 infection as a possible diagnosis. In addition, women infected with COVID-19 may be asymptomatic until their admission in labor and beyond,[6] which in itself poses a significant risk of exposure for their family members (including the newborn) and all providers involved in their clinical care.

CONSIDERATIONS FOR TESTING ON ADMISSION

Screening criteria for COVID-19 infection usually include the following: (1) fever, (2) cough or shortness of breath, (3) diarrhea, and (4) any possible exposure to COVID-19. However, because women with COVID-19 infection may be asymptomatic at the time of admission and because some may present with overlapping pregnancy symptoms, universal screening may miss pregnant women infected with SARS-CoV-2 in communities with a high prevalence or high projected infection rate (eg, New York, New Orleans, Detroit, Chicago, Miami).[7,8] Universal testing with real-time reverse transcriptase–polymerase chain reaction (RT-PCR) tests for SARS-CoV-2 viral ribonucleic acid (RNA) may improve case detection in high prevalence communities. However, current assays may return false-negative results if the viral load is low or if specimen collection is incomplete.

The goals of COVID-19 testing specific to pregnant patients admitted to labor and delivery units are 2-fold: (1) to prevent vertical transmission and ensure separation of the neonate after birth and (2) to protect health care workers by ensuring use of appropriate personal protective equipment (PPE). Besides the unclear sensitivity of RT-PCR testing, the time for nucleic acid detection varies between 6 and 8 hours or longer depending on availability. Therefore, management of women on Labor and Delivery Units located in a community with a high prevalence of COVID-19 infection should err on the side of caution.

For purposes of clinical management and PPE use, women may therefore be categorized as follows (1) COVID-19 negative, (2) asymptomatic, (3) symptomatic (persons under investigation [PUI]), and (4) personally positive for COVID-19 testing. This information should be made available to all health care providers and updated at all times as it may change during the course of labor (from asymptomatic to symptomatic or, if tested, once the result becomes available).

Women who are COVID-19 positive (or high-risk PUI) should ideally be placed in an isolation room. Airborne infection isolation rooms (single-patient negative-pressure rooms with a minimum of 6 air changes per hour), if available, should be used if performance of aerosolizing procedures is anticipated. In general, isolation rooms suitable for droplet and contact precautions are recommended.[9] Strategies for exposure mitigation and cohorting, as well as considerations for transportation of patients who are PUI or COVID-19 should follow the same recommendations as for general patient cases.[10]

SYSTEMS PREPARATION

A multidisciplinary team of anesthesiologists, obstetricians, labor and delivery nurses, neonatologists, critical care experts, infectious disease and infection control experts, employee health services, environmental health services, and telemedicine services should create and implement protocols to support the management of patients with COVID-19 infection in the setting of a Labor and Delivery Unit. A side-by-side comparison of recommendations from many professional societies for labor and delivery units is presented in Table 1. For institutions with multiple labor and delivery sites, consideration should be given to designating 1 institution to care for patients with COVID-19 infection. This proved useful in managing patients during the SARS epidemic and for cases in the recent COVID-19 outbreak in Wuhan, China.[11–13]

Resource allocation within the Labor and Delivery Unit as well as other units (including intensive care unit) should be proactively addressed. It is imperative to establish a back-up team to care for patients without COVID-19 infection due to the time-intensive tasks of donning/doffing PPE, transporting the patient, providing anesthetic care, and performing surgery in patients with active COVID-19 infection.

From a logistical standpoint, a designated operating room within the Labor and Delivery Unit should be prepared. Dedicated trays (or carts) containing the most commonly used supplies and drugs for both neuraxial labor analgesia and cesarean delivery should be available to minimize traffic and contamination of anesthesia workstations and other anesthesia equipment.

PATIENT EVALUATION AND MONITORING

A pregnant woman who is PUI or COVID-19 positive should be evaluated (limiting unnecessary encounters) including vital signs, physical examination, and review of laboratory tests (complete blood

Table 1. Professional Society Recommendations for Labor and Delivery Comparison of Recommendations for Intrapartum Anesthetic Care of Known or Suspected COVID-19 Patients

	SOAP	ACOG	SMFM-SOAP	SOGC	RANZCOG	RCOA-OAA	RCOG
Initial publication	March 15, 2020	March 23, 2020	March 25, 2020	March 17, 2020	March 23, 2020	March 16, 2020	March 15, 2020
Date updated	March 23, 2020	March 26, 2020	March 27, 2020	March 26, 2020	March 29, 2020	March 27, 2020	March 28, 2020
Isolation room	Yes, preferably negative pressure	-	Yes, negative pressure for AGP	-	Yes	-	Yes
Mask on patient	-	Yes, surgical	Yes, surgical	Yes, surgical	Yes, surgical	Yes, surgical	Yes, surgical
Visitors and support people	Limit visitors and support people	Limit visitors and support people	Limit or eliminate visitors, special considerations apply	Yes, single asymptomatic	Yes, limited, asymptomatic	-	Yes, single asymptomatic, limit visitors to wards
PPE for non-AGP, first stage labor	Droplet and contact	Droplet and contact, airborne preferred	Droplet and contact	Droplet and contact	-	-	Droplet and contact
PPE for vaginal delivery, second stage labor	Droplet and contact	Droplet and contact, airborne preferred	Airborne reasonable, consider surgical drapes as additional barrier	Droplet and contact, consider airborne if risk of sudden deterioration	-	-	Droplet and contact
PPE neuraxial analgesia	Droplet and contact	Droplet and contact, airborne preferred	-	-	-	Droplet and contact	-
Neuraxial analgesia and anesthesia COVID-specific concerns	Labor analgesia encouraged early; performed by most experienced provider	-	Labor analgesia encouraged early	Labor analgesia encouraged early; performed by most experienced provider	-	Labor analgesia encouraged early, suggestion to check platelet count	Labor analgesia encouraged early
Use of nitrous oxide	Consider suspending use	-	Consider suspending use	-	Yes, no evidence of AGP, use filter	Yes, no evidence of AGP, use filter	Yes, no evidence of AGP, use filter
Use of postoperative NSAIDs	Data lacking, likely safe if asymptomatic	Data lacking	Data lacking, continue to use in asymptomatic and mildly symptomatic patients	-	-	-	-
Mode of delivery	-	Per obstetric indications	-	Per obstetric indications	Per obstetric indications	-	Per obstetric indications, no water births
Operative delivery	-	Follow usual clinical indications	Not precluded, consider performing in OR	-	-	-	Individualized decision
Elective cesarean or induction of labor with current COVID-19 infection	-	-	-	-	Preferable to delay until completion of isolation period, if possible	-	Evaluate safety of delaying procedure
PPE for cesarean delivery	Anesthesia team: droplet, contact, ideally airborne; if GA planned: all staff wear airborne, minimize staff in room at time of intubation and extubation	Ideally airborne for all staff	Ideally airborne for all staff for all cases	Airborne advised; if GA planned: all staff wear airborne, minimize staff in room at time of intubation and extubation	-	Neuraxial planned (and low risk of GA): droplet and contact; emergency cesarean: as above, risk assess need for airborne PPE; if GA planned: airborne PPE for all staff in room during intubation and extubation, minimize staff present, airborne for all staff if no time to allow for air turnover	Neuraxial planned (and low risk of GA): droplet, scrubbed staff waits outside of room until block successful; emergency cesarean: droplet for neuraxial, airborne if risk of GA; if GA planned: airborne for all staff

Abbreviations: ACOG, American College of Obstetricians and Gynecologists; AGP, aerosol-generating procedure; COVID-19, coronavirus disease 2019; GA, general anesthesia; NSAIDs, nonsteroidal anti-inflammatory drugs; OR, operating room; PPE, personal protective equipment; RANZCOG, Royal Australian and New Zealand College of Obstetricians and Gynaecologists; RCOA-OAA, Royal College of Anaesthetists-Obstetric Anaesthetists' Association; RCOG, Royal College of Obstetricians and Gynaecologists; SMFM-SOAP, Society for Maternal-Fetal Medicine-Society for Obstetric Anesthesia and Perinatology; SOAP, Society for Obstetric Anesthesia and Perinatology; SOGC, Society of Obstetricians and Gynaecologists of Canada.

count, comprehensive metabolic panel, and arterial blood gas, if needed) to assess appropriate level of care and monitoring plan for potential deterioration. Early multidisciplinary collaboration should be arranged to determine level of care, fetal monitoring, and delivery plan. Discussion of the risks and benefits for administering steroids for fetal lung maturity, magnesium for neuroprotection, and indomethacin for tocolysis should be addressed, since there is concern those drugs may worsen COVID-19 infection (Table 2).[9]

Avoiding urgent cesarean delivery is essential to reduce the risk for general anesthesia and provider exposure during uncontrolled transfers to the operating room. Therefore, ongoing assessment of both maternal and fetal statuses are key to balance risks of prolonged labor versus cesarean delivery. It is unclear whether uterine decompression improves maternal respiratory status and how the potential benefit balances against the known operative risks in the setting of COVID-19. On the other hand, prolonged maternal hypoxemia may ultimately cause fetal acidemia, leading to a more urgent cesarean delivery.[9]

Routine monitoring should include frequent vital signs (tailored to the current clinical status and adjusted as necessary) with the addition of continuous pulse oximetry (Spo_2) and strict input and output measurements to assure fluid restriction. Spo_2 goal should be an oxygen saturation ≥95%. Early warning criteria systems specific for obstetric patients may aid in early detection and prompt escalation of care.[16]

Women requiring supplemental oxygen, who develop increasing oxygen requirements or worsening hypoxia (Spo_2 < 95%), should have prompt arterial blood gas analysis with frequent clinical reassessment to guide the requirement for escalation of care and mechanical ventilation. High-flow nasal oxygen or noninvasive ventilation may be considered as temporizing measures but are generally discouraged due to the potential for greater aerosolization. In addition, increasing oxygen requirements serve as a marker of disease progression, with increasing risk of atelectasis and pulmonary consolidation. It is recommended to perform endotracheal intubation in a controlled manner minimizing exposure to health care workers and equipment with airborne precautions in an urgent/emergent situation.[17]

Table 2. Specific Considerations for Medication Use in PUI or COVID-19–Positive Patients During Labor, Delivery, and the Postpartum Period

	Considerations	Case Context	Mechanism
Oxygen[9]	The routine use of oxygen for fetal indications should be suspended	Overall, the use of oxygen for fetal indications is controversial	The use of high-flow nasal cannula or facemask oxygen may be an aerosolizing procedure
Nitrous oxide[9]	Discuss the relative risks and benefits of nitrous oxide for labor analgesia and consider suspending its use	Overall, for all parturients	"There is currently insufficient information about the cleaning, filtering, and potential aerosolization of nitrous oxide in labor analgesia systems in the setting of COVID-19"
Remifentanil/ fentanyl[14]	Consider avoiding the use of IV PCA opioids (remifentanil/fentanyl) for labor analgesia	Women at risk for respiratory depression and opioid-induced nausea and vomiting	Opioid-induced respiratory depression increases the risk of sedation, respiratory depression, and oxygen desaturation, and increases the risk for emergent airway instrumentation and aerosolizing procedures
Ketorolac/ ibuprofen[9,15]	For women who are asymptomatic or mildly symptomatic that require analgesic medication beyond acetaminophen, NSAIDs can continue to be used, as the alternative of opioids likely poses more clinical risks. For sick COVID-19 patients, consider avoiding NSAIDs	It has been suggested that the use of NSAIDs for management of COVID-19 symptoms may aggravate COVID-19 infection trajectory (although the evidence is not robust) The use of ACE inhibitors was suggested to increase the risk for COVID-19 infection	NSAIDs are associated with increased ACE2, to which COVID-19 binds
Dexamethasone[9]	Consider avoiding the use of dexamethasone for PONV prophylaxis	In all women undergoing cesarean delivery, alternative antiemetics should be administered to prevent vomiting	Prolonged exposure to high-dose steroids has been associated with worsening COVID-19 outcomes in the general population
Carboprost (Hemabate)[14]	Consider avoiding the use of carboprost for treatment of uterine atony	For women at risk of bronchospasm, use alternative second-line uterotonics	Prostaglandin F_2 alpha causes bronchoconstriction and pulmonary vasoconstriction
Magnesium sulfate[9]	Consider avoiding or as an alternative to usual dosing, a 4 g bolus dose may be preferred in the setting of mild respiratory distress	For women with increasing oxygen requirement, the risk:benefit ratio should be considered before using magnesium for fetal neuroprotection, or for preeclampsia without severe features	Magnesium sulfate has central nervous system and respiratory depressant effects

Abbreviations: ACE, angiotensin-converting enzyme; COVID-19, coronavirus disease 2019; IV, intravenous; NSAIDs, nonsteroidal anti-inflammatory drugs; PCA, patient-controlled analgesia; PONV, postoperative nausea and vomiting; PUI, persons under investigation.

One of the more serious complications of patients with COVID-19 is acute respiratory distress syndrome (ARDS). Ventilator management strategies for ARDS involve lung-protective strategies such as low tidal volumes (6 mL/kg using predicted body weight), plateau pressure <30 cm H_2O, and the combined use of reduced fraction of inspired oxygen (F_{IO_2}) with increases in positive end-expiratory pressure (PEEP) to maintain a partial pressure of oxygen (Pa_{O_2}) of 65–90 mm Hg.[18] Useful ventilator titration techniques using the ARDSnet ventilator protocol can be found on the ARDSnet website (www.ardsnet.org/files/ventilator_protocol_2008-07.pdf).[19] Pregnant patients have a physiological decrease in partial pressure of carbon dioxide (Pa_{CO_2}), and it is recommended to maintain a Pa_{CO_2} of 28–32 mm Hg with ventilation to augment off-loading of oxygen to the fetus. However, the priority is maintaining oxygenation with low tidal volumes and PEEP, and this strategy may not allow for maintaining the physiologic Pa_{CO_2} in pregnancy. Multidisciplinary discussion should determine the fetal monitoring and delivery plan during mechanical ventilation.

LABORING PATIENTS WITH ACTIVE COVID-19 INFECTION

Neuraxial labor analgesia remains a mainstay of obstetric care even with concurrent COVID-19 infection. In fact, early epidural placement is desirable to avoid exacerbation of respiratory symptoms with labor pain and to reduce the likelihood of general anesthesia if intrapartum cesarean delivery becomes needed.

The benefits of neuraxial analgesia in the setting of COVID-19 pneumonia are 2-fold: (1) for the patient, it will help avoid any exacerbation of respiratory status with intubation and mechanical ventilation and (2) for health care providers, it reduces the risks associated with aerosol exposure and transmission of COVID-19 infection during intubation and extubation, if general anesthesia is provided.

The risk of COVID-19 exposure for the anesthesiologist during neuraxial labor analgesia placement is presumably low, since this is not an aerosol-generating procedure. All health care workers in the room should wear contact (impervious gown and gloves) and droplet (surgical mask and eye protection) precautions. The patient should wear a surgical mask at all times to limit droplet spread, and the number of personnel present during placement of neuraxial labor analgesia should be minimized but with assistance readily available. Several strategies may minimize contamination of equipment and COVID-19 exposure in anesthesiologists, while also minimizing the consumption of PPE (Box 1; Figure).

A parturient who is symptomatic PUI, or COVID-19 positive, should have a complete blood count before neuraxial analgesia placement. Early studies from China suggested that thrombocytopenia may be associated with COVID-19 infection; in a cohort of 1099 patients, 36.2% had thrombocytopenia (<150,000 × 10^6/L).[20] A meta-analysis of 1779 patients with COVID-19 infection observed that platelet counts are lower in patients with more severe disease.[21] Though less common, a platelet count <100,000 × 10^6/L can occur; 3 studies of 243 patients reported a total of 6.6% patients with that level of thrombocytopenia.[22–24]

We suggest a platelet count on admission without the need to check serial counts before needle placement unless there is a major change in clinical symptoms. It is generally safe to perform neuraxial procedures at platelet counts of 70,000 × 10^6/L or above,[25] and, given the rare risk of spinal/epidural hematoma and the much higher risk of respiratory compromise with general anesthesia, neuraxial procedures at even lower platelet counts should be considered.

While theoretically possible, the risk of epidural or subarachnoid space seeding with viremic blood, causing encephalitis or meningitis, is exceedingly rare. At

Box 1. Empirical Strategies That May Be Implemented to Minimize Contamination of Equipment and COVID-19 Exposure of Anesthesiologists to Reduce the Use of PPE

1. Limit in-person encounters for preanesthesia evaluations by utilization of video—consultations (including for antenatal consultations for high-risk patients).
2. Limit encounters on admission to the labor floor—consider using mounted iPads in each labor room for hourly evaluations.
3. Limit the use of electronic devices or pens for written consents by use of electronically documented witnessed verbal consents.
4. Avoid bringing into the patients' room the epidural cart or tray—the required equipment (epidural kit) and drugs should be prepared and brought into the room in a bag before the procedure.
5. Have the most experienced anesthesiologist perform the procedure to ensure adequate placement and reduce the risk of accidental dural puncture that may require an epidural blood patch.
6. Increase the dosing of neuraxial medications for labor analgesia (eg, increasing the bupivacaine concentration from 0.0625% to 0.1%) or changing the setting of the programmed epidural intermittent bolus (eg, increasing the volume from 5 to 8 mL, or decreasing the interval from every 45 to 30 minutes) or adding neuraxial adjuvants (eg, epidural clonidine) to minimize intrapartum breakthrough pain requiring epidural top-up.
7. Round on parturients with video or phone calls into the patient's room for hourly assessments of general status and effects of neuraxial analgesia.
8. Ensure appropriate cleaning of all equipment in the room including the epidural pump and the on demand-button.
9. Limit encounters for postpartum rounds by utilization of video—consultations.
10. Consider suspending prolonged patient-controlled epidural analgesia services (if applicable).

Abbreviations: COVID-19, coronavirus disease 2019; PPE, personal protective equipment.

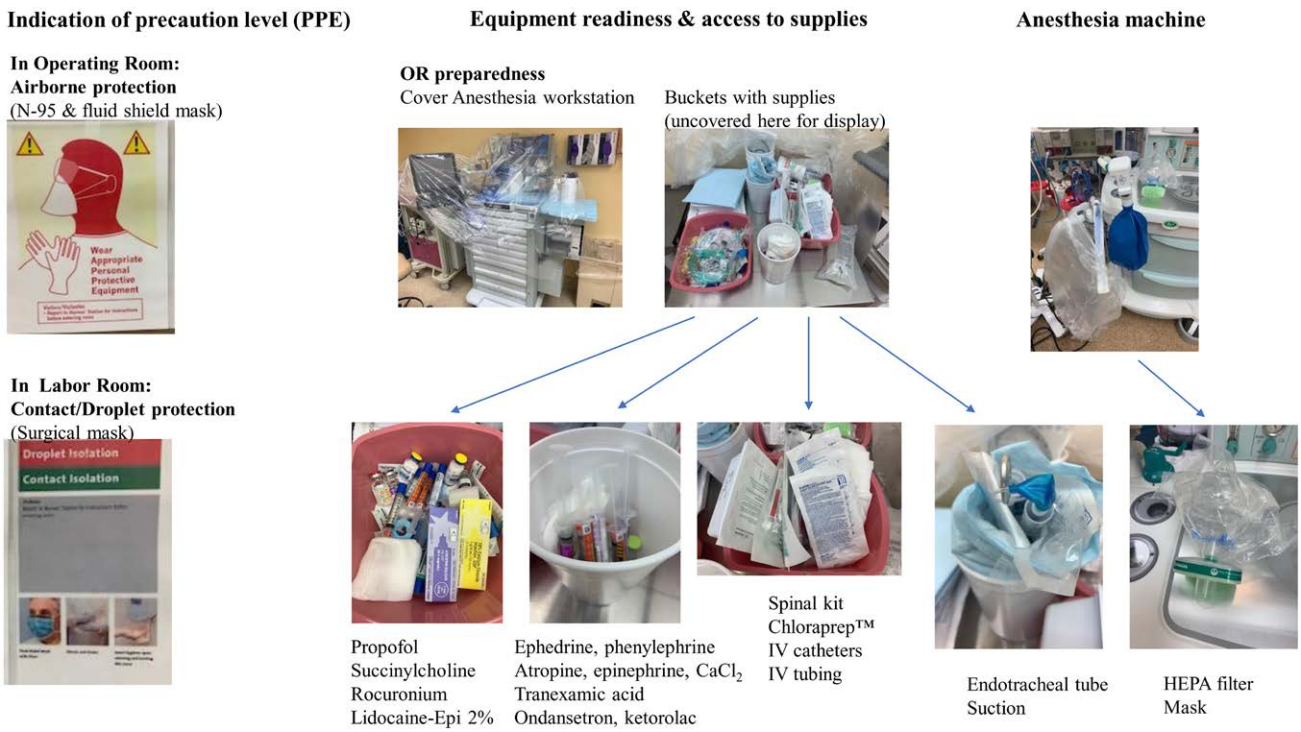

Figure. Set-up for OR and labor epidural analgesia. HEPA indicates high-efficiency particulate air; IV, intravenous; OR, operating room.

the time of this writing, there are 77 pregnant women reported in the literature who received uneventful neuraxial procedures for cesarean or vaginal delivery (4 combined spinal-epidural, 27 epidural, 46 spinal procedures; Table 3).[6,26–30] Spinal, combined spinal-epidural, epidural procedures all are acceptable, and no technique confers more risk that the other based on the literature available. None of the patients experienced neurologic sequelae.

Current recommendations on the use of nitrous oxide for labor analgesia suggest "there is insufficient information about the cleaning, filtering, and potential aerosolization of nitrous oxide in the setting of COVID-19." Individual Labor and Delivery Units should consider suspending use.[9] Additionally, the practice of high-flow oxygen for fetal distress does not improve fetal outcomes and should be suspended due to the risk of aerosolization.[9]

ANESTHESIA FOR CESAREAN DELIVERY

In reports from China, most women with a diagnosis of COVID-19 infection underwent a cesarean delivery.[26] In the absence of universal testing and rapid availability of results, COVID-19 status may not necessarily be known at the time of cesarean delivery. The baseline failure rate for conversion of labor epidural analgesia to cesarean delivery anesthesia is 5%.[31] Urgent intrapartum cesarean delivery represents an important risk factor for failed conversion from intrapartum neuraxial labor analgesia to cesarean delivery anesthesia—therefore, ongoing communication with the obstetricians is crucial to allow safe transfer to the operating room, and adequate time for initiation of surgical block to avoid general anesthesia.[31] To minimize the risk of exposure during urgent endotracheal intubation, airborne protection (N95 respirator mask) is recommended for all providers in the operating room unless the patient is known to be COVID-19 negative.

A publication from Wuhan, China, describing outcomes in 17 COVID-19–positive women undergoing cesarean delivery, concluded that "excessive hypotension" occurred in 12 of 14 cases with epidural anesthesia in comparison with the 3 women who had received general anesthesia; however, information about the blood pressure trends and description of the use of vasopressors is not reported.[27] A larger case series of 49 patients receiving spinal anesthesia (45 for cesarean delivery and 4 for orthopedic procedures) was well tolerated with stable blood pressure.[30]

In our early experience, maternal hypotension during cesarean delivery with epidural or spinal anesthesia has not been noted, most likely because prevention of hypotension with phenylephrine is part of our routine clinical practice. Along with antihypotensive medication, antiemetic medication should also be administered. However, we recommend using an alternative to dexamethasone in a PUI or patient with known COVID-19 infection given the risk of worsening clinical severity.[14] Specific considerations for medication use in PUI or COVID-19–positive patients

Table 3. Neuraxial Procedures Performed in Pregnant Women With COVID-19 Infection

Author	n	Neuraxial Procedure	Respiratory Status at the Time of Delivery	Febrile Before Procedure?	Neurologic Sequelae
Bauer et al[26]	14	1 CSE, 13 epidural	CT or radiological evidence of pneumonia 14 (100%), 1 patient on maximal noninvasive ventilation at time of CD	10 (71%)	None
Chen et al[27]	14	14 epidural	14 (100%) CT evidence of pneumonia	4 (29%)	None
Xia et al[29]	1	1 spinal	Spo_2 = 92% on room air, CT evidence of pneumonia	1 (100%)	None
Song et al[28]	1	1 CSE	Spo_2 = 86%–90% on room air, CT evidence of pneumonia	1 (100%)	None
Breslin et al[6a]	2	2 CSE	Asymptomatic at the time of placement, found to have COVID-19 infection postpartum	0	None
Zhong et al[30]	45	Spinal	Mild symptoms, no cases of severe pneumonia	While hospitalized, 5 (11%) of entire cohort including 4 orthopedic patients	None

Abbreviations: CD, cesarean delivery; COVID-19, coronavirus disease 2019; CSE, combined spinal-epidural; CT, computed tomography; Spo_2, pulse oximetry.
[a]Personal communication with Ruth Landau, Department of Anesthesiology, Columbia University College of Physicians and Surgeons, New York, NY, on March 29, 2020.

during labor, delivery, and the postpartum period are described in Table 2.

VERTICAL TRANSMISSION

Current understanding is that there is little evidence for vertical transmission in women who develop COVID-19 pneumonia in late pregnancy.[2,32–36] However, cases of possible in utero infection seem to be emerging including a recent report of a neonate born to a COVID-19 infected mother. This suggests in utero infection during the 23 days between maternal infection and delivery 23 days later and supported by elevated immunoglobulin M (IgM) antibodies, which are not transferred to the fetus via the placenta.[37–40] Serological testing of virus-specific IgG and IgM antibodies may alternatively be used if RT-PCR testing is not available or if RT-PCR seems to be yielding a false-negative result.[41]

POSTPARTUM CONSIDERATIONS

Postpartum considerations for parturients with COVID-19 infection include adequate management of usual postpartum issues (postpartum hemorrhage, pain, hemodynamic status) as well as judicious fluid management, surveillance for respiratory decompensation, and early involvement of subspecialty care as needed. Appropriate isolation of mother and child on the postpartum unit is also recommended.[42]

Postpartum Hemorrhage

In the setting of postpartum hemorrhage due to uterine atony, carboprost tromethamine (Hemabate; Pharmacia & Upjohn Co, Division of Pfizer Inc, New York, NY) followed by endotracheal intubation was reported to have precipitated immediate and prolonged bronchospasm in a patient who was subsequently found to be COVID-19 positive.[6,43] Oxytocin and methylergonovine as a second-line choice may be preferred, due to the potential for bronchospasm with carboprost tromethamine (Hemabate), and aerosolization of viral particles during bronchospasm management.

Postpartum Pain Management

It has been posited that nonsteroidal anti-inflammatory drugs (NSAIDs) for management of symptoms suggestive of COVID-19 infection may worsen the clinical course of COVID-19 patients; however, this remains controversial and robust data are lacking. At this point, for women who are asymptomatic or mildly symptomatic with pain not well controlled with acetaminophen, NSAIDs can continue to be used, as the alternative of opioids likely poses more clinical risks.[9]

Management of Postdural Puncture Headache

There are no reported cases of accidental dural puncture resulting in postdural puncture headache (PDPH) in a patient with a COVID-19 infection, and consequently, no available guidance. Similar to usual care, conservative measures should be initially provided.

Usual contraindications to the performance of an epidural blood patch (eg, fever, thrombocytopenia, or other coagulation issues) should apply in a COVID-19 patient. Mitigating the risk of a serious neurologic complications with untreated PDPH[44] versus that of viral seeding in the epidural space with an epidural blood patch will require a case-by-case approach. Postponing the epidural blood patch is recommended in women who are actively ill. Individual assessment of the benefits and risks should be assessed and shared decision-making should be engaged with the patient before proceeding.

Because a nasal sphenopalatine ganglion (SPG) block is likely an aerosol-generating procedure due to the injection/insertion directly into the nasal cavity, it should be avoided to minimize the risk of transmission to health care workers.

CONCLUSIONS

Key points emerging in the past weeks from the literature and our experience in Labor and Delivery Units in the United States are that pregnant women may be asymptomatic on admission in labor, and that symptoms of COVID-19 infection may initially be missed or obscured if chorioamnionitis is suspected during labor. Although most women with COVID-19 infection will not present with pneumonia and respiratory decompensation during labor, escalation of care and advanced critical care resources may become necessary in the postpartum period.

In fact, most of the considerations surrounding management of the parturient with suspicion of or known COVID-19 infection include not only best strategies to ensure safe care for the parturient but also those to prevent health care worker exposure to SARS-CoV-2 and contracting COVID-19.

Anesthesiologists are deemed at significant risk of viral exposure during endotracheal intubations of COVID-19–infected patients, and all strategies should be applied to avoid general anesthesia in women who are either untested or known to be COVID-19 positive.

Early neuraxial labor analgesia is strongly recommended to ensure availability of neuraxial anesthesia in the event of an intrapartum cesarean delivery, and spinal anesthesia should be provided if needed. If deemed necessary and unavoidable, provision of general anesthesia should follow general recommendations for intubation and extubation in the setting of COVID-19–infected patients.

The changes in workflow that result from the need to ensure adequate PPE (contact/droplet protection for nonaerosolizing procedures such as [eg, epidural placement] or airborne protection for cesarean deliveries due to the possible conversion to general anesthesia) are considerable and require thorough planning and preparedness.

Close communication around COVID-19 status of all patients admitted to the Labor and Delivery Unit is essential, and anticipation of emergencies is of the essence. Overall, providing the best clinical care for pregnant and postpartum women with COVID-19 infection also must take into account strategies to prevent health care worker exposure to SARS-CoV-2 and contracting COVID-19.

DISCLOSURES

Name: Melissa E. Bauer, DO.
Contribution: This author helped write the manuscript and edit the critical content.
Name: Kyra Bernstein, MD.
Contribution: This author helped write the manuscript and edit the critical content.
Name: Emily Dinges, MD.
Contribution: This author helped write the manuscript and edit the critical content.
Name: Carlos Delgado, MD.
Contribution: This author helped write the manuscript and edit the critical content.
Name: Nadir El-Sharawi, MD.
Contribution: This author helped write the manuscript and edit the critical content.
Name: Pervez Sultan, MD.
Contribution: This author helped write the manuscript and edit the critical content.
Name: Jill M. Mhyre, MD.
Contribution: This author helped write the manuscript and edit the critical content.
Name: Ruth Landau, MD.
Contribution: This author helped write the manuscript and edit the critical content.
This manuscript was handled by: Thomas R. Vetter, MD, MPH.

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