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What obstetricians should know about obstetric anesthesia during the COVID-19 pandemic

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Abstract

The COVID-19 pandemic has prompted obstetric anesthesiologists to reconsider the ways in which basic anesthesia care is provided on the Labor and Delivery Unit. Suggested modifications include an added emphasis on avoiding general anesthesia, a strong encouragement to infected individuals to opt for early neuraxial analgesia, and the prevention of emergent cesarean delivery, whenever possible. Through team efforts, adopting these measures can have real effects on reducing the transmission of the viral illness and maintaining patient and caregiver safety in the labor room.

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Introduciton

The Coronavirus Disease 2019 (COVID-19) pandemic has prompted innumerable alterations in the practice of anesthesiology. From the cancelling of elective surgical cases, to rapid building and staffing of make-shift intensive care units, many anesthesiologists in even moderately affected areas have seen the fundamentals of their work shift focus. Unlike many anesthesiologists working in general service operating rooms, the basic demands on obstetric anesthesiologists working in Labor and Delivery Unit have not changed; pregnant women are still going into labor, are still giving birth, and continue to request or require related services only an anesthesiologist can provide. Yet, however typical the anesthesiologist’s activities may seem, anesthesia care rendered in the Labor and Delivery Unit in the time of the COVID-19 pandemic has become anything but routine. This review will examine general recommendations and changes in obstetric anesthetic practice on the Labor and Delivery Unit, in particular emphasizing (1) how general anesthesia (GA) should be actively avoided, (2) the benefits of neuraxial labor analgesia in COVID-19 infected women, and (3) the need to avoid urgent cesarean delivery whenever possible.

Background, definitions and general concerns

The first reported clinical cases resembling COVID-19 infection were reported in November 2019 in Hubei Province, China, with the number of global confirmed cases topping 4 million world-wide by mid-May 2020. Unlike previous viral pandemics, COVID-19 incidence, prognosis and maternal and neonatal outcomes do not appear to be worse in pregnant women compared to that in the general population.
Because symptoms of COVID-19 in parturients can be similar to those seen during early or prolonged labor, COVID-19 infection may be concealed by symptoms of labor. This has practical implications for the approach to women admitted to Labor and Delivery Units. With the increased availability and speed of SARS-CoV-2 testing, institutions have widely advocated for universal testing of women admitted for labor and delivery.1 If testing capacity allows, this approach should be strongly considered even in areas of lower prevalence.

As the pandemic has evolved, a significant proportion of women have tested positive for COVID-19 infection in the absence of symptoms.4 The infectivity of these patients is unclear. However assuming that asymptomatic, positive patients can spread the disease, risk mitigation strategies suggest that all patients, until tested negative, are presumptive positive and possibly infective. The general recommendations which follow for care of the COVID-19 infected pregnant woman should also apply to patients under investigation (PUIs). (Table 1)

**Peripartum labor analgesia consultations**

Communication amongst obstetricians, anesthesiologists, neonatologists and nurses is more crucial that ever during the COVID-19 pandemic. It cannot be emphasized enough that anesthesiologists need to be actively involved in the care of sick or potentially complex patients early in their presentation to the labor and delivery unit. A consultation and physical exam by an anesthesiologist in appropriate personal protective equipment (PPE) and the patient in, at least, a surgical face mask, should occur promptly after admission. Alternately, if physical exam is not deemed critical and if video conferencing hardware is available (tablet, phone, screen with webcam), the anesthesiologist may forgo an in-person interview with the patient and do so virtually. The latter approach conserves PPE and saves the anesthesiologist and patient (and partner, if present) from mutual exposure.

For patients who are being admitted for routine induction or labor, the anesthesiologist may delay interacting with the patient until the COVID-19 status is known, or at the time of neuraxial labor analgesia placement, whichever occurs first. However, anesthesiologists are encouraged to proactively learn about the patients electronically to determine if earlier intervention would be helpful. While anesthesiologists can generally differentiate between patients needing immediate versus delayed consultation by this review, a direct communication and, if thought to be necessary, request for consultation from the obstetrician, would be a high-value interaction.

**Labor analgesia**

**Neuraxial labor analgesia**

SARS-CoV-2 infection is not a contraindication to neuraxial labor analgesia. In fact, COVID-19 infection should prompt an anesthesia consultation with the goal to promote early placement of neuraxial labor analgesia. Administration of neuraxial anesthesia is critical initial strategy in avoiding general anesthesia if an urgent intrapartum cesarean delivery becomes indicated. This statement has been endorsed by the Society for Maternal-Fetal Medicine (SMFM) and the Society for Obstetric Anesthesia and Perinatology (SOAP) in a joint practice recommendation.5

Otherwise healthy COVID-19 infected parturients who are asymptomatic or mildly symptomatic require no additional laboratory testing prior to neuraxial placement and should be treated as per general recommendations prior to neuraxial labor analgesia placement. In pregnancy, a platelet count of $75,000 \times 10^9/L$ or above is considered to be associated with an extremely low risk of spinal epidural hematoma after a neuraxial procedure.6,7 For patients with moderate to severe symptoms of COVID-19 infection, pre-placement laboratory tests should be considered, as thrombocytopenia, although

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### Table 1 – Suggested approach to women admitted on Labor and delivery Units based on COVID-19 status.

| Patient PPE | Operating room set up | Recovery | Negative RT-PCR test within 24 h No new history of symptoms | Asymptomatic | PUI | Positive RT-PCR result |
|-------------|-----------------------|----------|-----------------------------------------------------------|-------------|-----|------------------------|
| Per usual   | Per usual             | Per usual| COVID-19 Negative Already completed | COVID-19 Positive | Nasal swab (rapid, if possible) | COVID-19 Positive |
| Face mask   | Mask and gloves       | HEPA filter on anesthesia machine, machines covered, drugs and consumables segregated | Face mask | Isolate | Nasal swab* | Isolate or cohort |
| Mask and gloves | Droplet and contact | Avoid contaminating supplies and equipment | Mask, gloves, gown, eye protection | | | |
| Non-OR Anesthesia provider PPE | N95 mask, gloves, impervious gown, eye protection | Airborne, droplet and contact | | | |

1. All patients should be screened for COVID-19 symptoms (subjective or measured fever $\geq 37.8\degree C$, cough, shortness of breath, sore throat, fatigue, myalgia, congestion/runny nose, diarrhea, shaking chills or loss of taste or smell) at admission and subsequently per-shift.
2. Assuming universal testing, patients who present in middle column would move to right or left column with RT-PCR result. Backspace Sites without universal testing will need to determine local approach.

* per local policy, may need repeated negative tests in order to be considered COVID-19 negative.
As with all interactions, a COVID-19 infected parturient should maintain a mask over her mouth and nose during the placement of neuraxial analgesia. Placement of neuraxial analgesia is not considered an aerosolizing procedure, hence only droplet and contact, and not airborne, precautions should be followed by all caregivers in the room. One exception may be the support person, usually a nurse, who is holding the patient during placement, as that person’s may be close to the parturient’s face. That support person may wish to reposition away from the patient’s face, or consider following airborne precautions (notably an N95, or similar, mask).

For all COVID-19 positive patients, a constant consideration of the anesthesiologist should be to uphold standards of care and patient safety while minimizing caregiver exposure. Neuraxial analgesia infusions can be modified to maintain a safety profile and also minimize the need for physician administered dosing of epidural catheters (top-ups). By increasing the local anesthetic concentration in the epidural infusion, adding adjuvants (e.g. clonidine), and/or by increasing the rate or volume of the infusion, the anesthesiologist can increase the density of the block, reducing the need for top-offs. These strategies should be cautiously carried out to avoid maternal hypotension hence, these alterations may not be appropriate in all cases.

There should be added emphasis on assuring that an epidural catheter in a COVID-19 infected parturient is well-secured and well-functioning at all times. While the epidural’s functionality is the responsibility of the anesthesiologist, evaluation by all care teams of the effectiveness of neuraxial analgesia should be encouraged. Compared to standard care in non-infected patients, the anesthesiologist may be more likely to replace a questionably functional epidural catheter in COVID-19 infected patients, in hopes to avoid urgent situations that may increase the odds for patient adverse outcomes (e.g. accidental dural puncture during a replacement of epidural catheter, or general anesthesia if urgent cesarean delivery) or avoidable exposures for healthcare providers (rushed replacement of neuraxial analgesia/anesthesia or general anesthesia in the operating room).

Patients with moderate to severe COVID-19 symptoms will likely require a modified approach to the maintenance of neuraxial labor analgesia. Depending on the severity of the disease, this may include continuous pulse oximetry and placement of an arterial catheter for frequent blood gas analysis. Patients with significant but stable disease and labor which is progressing may continue to be candidates for vaginal delivery, but changes in symptoms, including shortness of breath, increasing oxygen requirements, and/or decreasing PaO2, or increasing acidemia should be triggers to reconsider mode of delivery.

**Inhaled nitrous oxide**

Inhaled nitrous oxide (N2O) has re-emerged as a popular option for labor analgesia, either early, as a bridge prior to neuraxial labor analgesia, or for second stage pain relief in women with no neuraxial labor analgesia. However, in the context of the pandemic, it is not currently recommended.

First, there is insufficient data regarding appropriate cleaning of the apparatus. Second, potential aerosolization of the virus during administration suggest the risks outweigh the benefits of this modality. Third, a parturient using inhaled N2O will not be able to wear a surgical face mask, which exposes healthcare providers, as well as support people allowed in the labor room. Last, inhaled N2O during labor may cause nausea and vomiting, considered to be an aerosol generating event, which may further contribute to viral transmission.

**Intravenous patient-controlled analgesia**

In the general population, opioid-based intravenous patient-controlled analgesia (PCA) is inferior to neuraxial analgesia for labor analgesia, and carries significant risks for both mothers and babies. Its downsides are even more pronounced in COVID-19 infected parturients. Maternal sedation and respiratory depression in a patient with impaired oxygenation and ventilation may exacerbate hypoxia and hypercarbia. These physiologic disturbances may not be well tolerated by the parturient or fetus and may lead to direct or indirect fetal depression increase the risk of cesarean delivery.

**Anticoagulation**

Management of anticoagulation has been an intense focus of COVID-19 protocols. While studies are currently lacking in the obstetric population, there is evidence that non-pregnant patients hospitalized with COVID-19 infection have a higher risk of thromboembolic events compared to non-infected patients. Decisions to administer unfractionated or low molecular weight heparin to pregnant patients can be especially challenging due concerns over spinal-epidural hematoma with neuraxial anesthesia placement and hemorrhage at the time of delivery. Recommendations for antepartum thromboprophylaxis should follow institutional guidelines (which may include unfractionated heparin 5000 units subcutaneous twice or three times daily). Provision of neuraxial analgesia/anesthesia in pregnant women receiving thromboprophylaxis should follow the SOAP Consensus statement.

**Anesthesia for cesarean delivery**

**Operating room preparation**

Anticipating cesarean delivery for SARS-CoV-2 infected patients is an important part of labor and delivery preparations. Depending on architectural details, including location of operating rooms, proximity to other areas, and specifics of ventilation of the operating rooms, as well as usual patient flow, number of operating rooms available, and expected patient volume, a site may choose to designate certain operating rooms for SARS-CoV-2 infected patients, or may prepare all operating rooms for SARS-CoV-2 infected patients. Practically, because Labor and Delivery Units will be caring for patients of unknown COVID-19 status with some frequency, the latter strategy will likely make more sense.
The guiding principles of preparing an operating room for a SARS-CoV-2 infected patient are two-fold. First, it should be taken into account that an aerosol-generating procedure or event may occur (Box 1). The risk of exposure is probably most directly borne by the anesthesia team due to their proximity to the patient’s face and mouth, but is shared by all operating room personnel. In the United States, about 5% of cesarean delivery are done under general anesthesia,16,17 and although this prevalence can likely be reduced with practice changes noted above, at times urgent general anesthesia may be required. For this reason, it is strongly recommended that at least the entire anesthesia team, if not the entire operating room team, take airborne, droplet and contact isolation precautions for any PUI or SARS-CoV-2 infected patient in the operating room, no matter how unlikely general anesthesia may seem. Second, no matter the team’s attention to detail, there is a high risk of contaminating items within the operating room. There is ample literature about the need to protect anesthesia machines (ventilators) from viral contamination with high efficiency particulate air (HEPA) filters.18,19 Larger and critical items can remain in operating rooms covered with clear, impervious sheaths to minimize contamination (Fig. 1). Efforts should be made, a priori, to remove all non-essential items from the designated operating rooms. Quantities of drugs, syringes, needles and other frequently used items can be gathered in “case packs,” which could be expected to be handled by potentially contaminated hands during the course of a case.20 After the case, unused items from these packs could be wiped down with alcohol- or bleach-based solutions (if possible), segregated in impervious bags for a time beyond the viral viability period, or disposed of.

**Box 1. Procedures and events considered to be potentially aerosol generating during anesthetic care in Labor and Delivery Units.**

- Nebulizer administration
- O₂ administration (> 5 L)
- Retching or vomiting
- Bag-mask ventilation
- Non-invasive ventilation (CPAP, BiPAP)
- Endotracheal intubation
- Endotracheal tube suctioning
- Endotracheal extubation

**Non-emergent cesarean delivery**

COVID-19 infected women with minimal to mild symptoms for scheduled cesarean delivery require few, if any modifications to a typical anesthetic plan; either spinal, epidural or combined spinal epidural, depending on the patient’s presentation, history and local practice. The anesthesiologist may consider increasing the dosage of the local anesthetic in the neuraxial solution and/or adding adjuvants (e.g. clonidine, higher dose of morphine) with the idea that these actions would prolong the duration of the anesthetic, a protection against needing general anesthesia should the case last...
longer than expected. An early publication from China pos-
tated that ‘exaggerated’ hypotension may occur with neuraxial anesthesia in women with SARS-CoV-2 infection. However this conclusion has been widely questioned since prevention of hypotension is standard of care, and doesn’t seem to have been practiced as part of the study. Supplemental oxygen should not be used unless specifically indicated (SpO2<95% prior to delivery or SpO2<90% or lower after delivery) as this is an aerosol generating procedure. If supplemental oxygen is needed, the patient should wear a surgical mask over the nasal cannula or face mask.

The anesthetic plan for cesarean delivery of a woman with COVID-19 infection with more significant symptoms (hypoxemia requiring FiO2>50%, moderate to severe acide-
ma, and/or the need for vasopressors) requires modifica-
tions to the above approach. In patients with severe disease, respiratory rate is usually elevated (often more than 35 breaths per minute), individual breaths are shallow, and the patient is using accessory muscles of respira-
tion causing increased work of breathing. Arterial blood gas analysis in these patients often reveals a metabolic or mixed metabolic/respiratory acidosis, decreased carbon dioxide and a large alveolar-arterial gradient. The ability of these patients to maintain their oxygen saturation while spontaneously breathing is often precarious; the anesthetic approach must strive to interfere with respira-
tory drive and mechanics as little as possible.

An arterial line should be placed before the induction of anesthesia in order to facilitate frequent arterial blood gas analysis, as well as close monitoring of blood pressure. Neuraxial anesthesia can still be employed in many of these patients, but a single shot spinal anesthesia might not be recommended. The standard spinal anesthetic technique involves a single large dose of local anesthetic (typically hyperbaric bupivacaine 0.75%–12–15 mg) and opioid adju-
vants to achieve a reliable, quick onset block. The rapid onset of a spinal block also leads to peripheral vasodilation and hypotension and standard practice is to prevent and manage with vasopressors (usually a phenylephrine infusion). However the rapid onset of a single shot spinal might not be well tolerated in a patient who already has some degree of inflammatory mediated vasodilation. Additionally, the rapid onset of thoracic dermatomal level (usually to T4) weakening the accessory muscles of respiration, may cause the patient to decompensate. Finally, a single-shot spinal technique will not allow prolonged post-cesarean pain man-
agement.

Either an epidural block or a combined spinal epidural (with low dose spinal) would be an appropriate neuraxial technique for a patient with significant COVID-19 infection. The benefits of these techniques in the context of a potentially hemody-
namic and respiratory compromise is the slower onset and titratable response. The relatively titratable nature of these neuraxial anesthetics should allow the anesthesiologist to incrementally dose the epidural catheter to achieve (and maintain) an anesthetic level adequate for surgery but which minimizes motor block to the accessory muscles of respira-
tion. The downside of an epidural-based anesthetic is that it is not quick to place or dose, and it may not achieve the same density of block as a spinal anesthetic.

**Box 2. Strategies to reduce the necessity of general anesthesia during the COVID-19 pandemic.**

**Preparedness – communication and education**
Commitment of obstetric care team to support early epidural placement in high risk patients
Antenatal messaging to and/or consultations with parturients
Education of obstetric care team with regards to specific risks of general anesthesia for patients and healthcare providers
Simulation and drills on safe and effective intrapartum transfers to the operating room in women requiring a cesarean delivery

**During labor**
Consultation on admission encouraging early epidural placement
Optimization of labor analgesia & ensuring functionality of epidu-
ral catheter
Low threshold for replacing questionable epidural catheters
Close and timely communication between obstetricians, anes-
esthesiologists and nurses regarding changes in parturient or fetal status
Pre-cesarean huddles to communicate COVID-status (RT-PCR neg-
ative, PUI, RT-PCR positive)
Safe and timely transfers to the operating room if cesarean deliv-
ery is indicated

**Emergent cesarean delivery**
Speed is often a critical component of anesthetic care on the Labor and Delivery Unit. During the time of the pandemic, general discussions as well as patient-specific communica-
tions amongst care team members with regard to this issue are a crucial aspect of patient and provider safety. Prior to entering the operating room, personnel must be given time to properly don PPE. Different strategies may be useful to ensure quick, and correct, selection and application of PPE including: (1) appropriate placement of PPE near operating rooms with instructive signage (2) simulations or practice sessions on PPE use and (3) a team member to serve as a “spotter,” checking each individual’s donning effort before he or she enters the operating room.

Outside of the pandemic, for truly emergent operating room cases, general anesthesia is often a consideration. How-
ever, due to the risks to the patient and caregivers, general anesthesia is best avoided in COVID-19 positive patients (Box 2). In fact, SARS-CoV-2 infection has forced a difficult reassessment of under what circumstances general anesthe-
sia is required. Based on pooled data evaluating pathogens’ transmission during severe SARS outbreaks, the odds of infection for healthcare providers during tracheal intubation was 6.6-fold higher compared to that among providers not exposed to intubation. As mentioned previously, efforts must be made to encourage neuraxial analgesia placement and avoid emergent cesarean delivery in patients with SARS-
CoV-2 infection, whenever possible.

If there does need to be a cesarean delivery on a patient who does not have an epidural catheter and is COVID-19 posi-
tive, the anesthesia team will need to weigh the risk of gen-
eral anesthesia, including the risk staff exposure, to the possible risk of delay due to placement of a neuraxial block (typically a single shot spinal). This is an ethically fraught question, as safety of the care team is not amongst the usual concerns when considering a care plan for a patient on Labor
and Delivery Unit. In experienced hands, a spinal placement may take no longer than induction of general anesthesia, and ‘rapid sequence spinal’ is definitely an option in emergencies, particularly in the setting of a difficult airway. Even in the setting of fetal distress, the putative 2–3 min that may have been saved between arrival into the operating room and the time of delivery do not justify the increased risk of a general anesthetic, in this case for both mothers and healthcare providers.

If general anesthesia does become necessary either before or during the course of a cesarean delivery, several safety measures should be followed. First, only the fewest number of individuals should be present in the operating room at the time of the intubation. Depending on the timing of the need for general anesthesia, this could include nurses and part of all of the surgical team stepping out of the room during the intubation. Second, the anesthesiologist should ensure that viral particles will be excluded from the ventilator by the application of a HEPA filter, usually between the endotracheal tube and the breathing circuit. Not doing so could contaminate the ventilator, requiring a deep cleaning that could take it out of service for days or weeks. Third, the intubation should be completed in as quick a time as possible. This means optimizing intubation conditions (patient positioning, bed height, etc.), rapid sequence induction (where the patient is anesthetized and paralyzed by rapid doses of intravenous medications), avoiding bag-mask ventilation, and completing the actual act of intubation efficiently, ideally with a video-laryngoscope. After the intubation is complete, the anesthesiologist must remain vigilant about the cleaning or disposal of the items used during endotracheal intubation.

Similar to intubation, extubation is considered an aerosol generating procedure, and precautions should be taken at the time of the removal of the endotracheal tube, including minimizing the number of people present in the room, administration of antiemetic drugs prior to the extubation, extubation to face mask or nasal canula at low oxygen flow rates and discouraging the patient from coughing after a patient is extubated.

### Intraoperative considerations

Intraoperative recommendations in patients with SARS-CoV-2 infection are consistent with standard practice recommendations for enhanced recovery after cesarean (ERAC) pathways (Box 3). Particular emphasis should be on avoiding retching and vomiting as these are aerosolizing events. Avoidance of the nausea which can accompany the onset of the spinal block due to spinal hypotension can be achieved by administration of vasopressors immediately after the block, usually a phenylephrine infusion, and by the use of prophylactic antiemetics. In addition, there is growing evidence that uterus exteriorization during cesarean delivery significantly increases intraoperative nausea and vomiting and should in general be avoided, but even more so in patients with SARS-CoV-2 infection.

### Post-delivery period

For asymptomatic or mildly symptomatic patients, postoperative analgesia should be similar to that delivered to COVID-19 negative patients, including but not limited to ibuprofen, acetaminophen and neuraxial preservation-free morphine. In patients with severe symptoms of SARS-CoV-2 infection, there may still be a role for ibuprofen and acetaminophen, however, as renal and liver dysfunction may accompany severe COVID-19 infection, these analgesics may be contraindicated for other reasons. Alternative strategies to postoperative analgesia in these patients include patient controlled epidural analgesia (PCEA), trunical blocks, and even low-dose ketamine infusion. The use of intravenous and oral opioids should be minimized as they present a risk of respiratory depression as well as nausea and vomiting. The presence of an indwelling epidural catheter should not be a contraindication to prophylactic anticoagulation.

### Conclusion

The successful care of patients on the Labor and Delivery Unit is dependent on communication and coordination between obstetricians, anesthesiologists, neonatologists and nurses. The benefits of proactive education and decision making are amplified during the COVID-19 pandemic, where incorrect choices can lead to safety lapses for patients and caregivers, alike. By adopting several key anesthetic-related practice changes, including emphasizing the need to avoid general anesthesia, advocating for early placement of neuraxial analgesia in COVID-19 infected women, and preventing the need...

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**Box 3. Specific anesthesia considerations for cesarean delivery in the patient with SARS-CoV-2 infection.**

1. Minimize the necessity for general anesthesia (preoperatively or intraoperatively)
2. Spinal anesthesia is the preferred anesthetic if rapid onset is desired
3. Combined-spinal epidural (or epidural if indwelling catheter) may be preferred if slow titration is desirable
4. Minimize the odds of intraoperative nausea and vomiting
   - phenylephrine infusion
   - antiemetics (ondansetron, metoclopramide)
   - avoidance of uterine exteriorization
5. Multimodal opioid-sparing analgesia should be initiated as per ERAC protocols
   - Acetaminophen 650 mg q6h
   - Ibuprofen 600 mg q6h (unless specifically contraindicated)
   - Oxycodone 5 mg for breakthrough pain (maximum daily dose 30 mg)

Multimodal analgesia should be initiated and maintained as per usual practice. Outside of standard contraindications (e.g. thrombocytopenia, renal insufficiency), there is no evidence to support avoidance of nonsteroidal anti-inflammatory drugs (NSAIDs) for management of post-cesarean pain in COVID-19 positive patients. NSAIDs should be used, as the alternative of opioids likely poses more clinical risks.
for emergent caesarean delivery whenever possible, the anaesthesia team can contribute to creating a safer environment for all in Labor and Delivery Units.

REFERENCES

1. Bauer M, Bernstein K, Dinges E, et al. Obstetric anesthesia during the COVID-19 pandemic. Anesth Analg. 2020;131(7):15.
2. Pierce-Williams RAM, Burd J, Felder L, et al. Clinical course of severe and critical COVID-19 in hospitalized pregnancies: a US cohort study. Am J Obstet Gynecol MFM. 2020;2(3):100134.
3. Breslin N, 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;2(2):100118.
4. 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;382:2163–2164.
5. https://s3.amazonaws.com/cdn.smfm.org/media/2327/SMFM-SOAP_COVID_LD_Considerations_-_revision_4-14-20_-_changes_highlighted.pdf. Accessed 11 May 2020.
6. Bauer ME, Toledano RD, Houle T, et al. Lumbar neuraxial procedures in thrombocytopenic patients across populations: a systematic review and meta-analysis. J Clin Anesth. 2020;61:106666.
7. Lee LO, Bateman BT, Khetarpal S, et al. Risk of epidural hema toma after neuraxial techniques in thrombocytopenic parturients: a report from the multicenter perioperative outcomes group. Anesthesiology. 2017;126(6):1053–1063.
8. Bauer ME, Chiware R, Pancaro C. Neuraxial procedures in COVID-19 positive parturients: a review of current reports. Anesth Analg. 2020 https://journals.lww.com/anesthesia-analgesia/Citation/publishead/Neuraxial_procedures_in_COVID_19_positive.positive.95732.aspx.
9. Vallejo MC, Zakowski MI. Pro-con debate: nitrous oxide for labor analgesia. Biomed Res Int. 2019;2019:4618798.
10. Morawaska L. Droplet fate in indoor environments, or can we prevent the spread of infection. Indoor Air. 2006;16(5):335–347.
11. Aaronson J, Abramovitz S, Smiley R, Tangle V, Landau R. A survey of intravenous remifentanil use for labor analgesia at academic medical centers in the United States. Anesth Analg. 2017;124(4):1208–1210.
12. Van de Velde M, Carvalho B. Remifentanil for labor analgesia: an evidence-based narrative review. Int J Obstet Anesth. 2016;25:66–74.
13. Leffert L, Horlocker T, Landau R. Don’t throw the baby out with the bathwater: spinal-epidural hematomas in the setting of obstetric thromboprophylaxis and neuraxial anesthesia. Int J Obstet Anesth. 2019;39:7–11.
14. https://soap.org/education/provider-education/expert-summaries/interim-considerations-for-obstetric-anesthesia-care-related-to-covid19/covid-19-faqs-for-providers/. Accessed 11 May 2020.
15. Leffert L, Butwick A, Carvalho B, et al. The Society for obstetric anesthesia and perinatology consensus statement on the anesthetic management of pregnant and postpartum women receiving thromboprophylaxis or higher dose anticoagulants. Anesth Analg. 2018;126(3):928–944.
16. Guggieleninotti J, Landau R, Li G. Adverse events and factors associated with potentially avoidable use of general anesthesia in cesarean deliveries. Anesthesiology. 2019;130(6):912–922.
17. Mhyre JM, Sultan P. General anesthesia for cesarean delivery: occasionally essential but best avoided. Anesthesiology. 2019;130(6):864–866.
18. https://www.apsf.org/news-updates/particle/spread-within-the-circuit-of-the-anesthesia-machine-lessons-learned-during-covid-19-pandemic/. Accessed 11 May 2020.
19. https://www.apsf.org/faq-on-anesthesia-machine-use-protection-and-decontamination-during-the-covid-19-pandemic/. Accessed 11 May 2020.
20. https://www.apsf.org/news-updates/optimizing-infection-control-and-or-management-during-the-covid-19-pandemic/. Accessed 11 May 2020.
21. Chen R, Zhang Y, Huang L, Cheng BH, Xia ZY, Meng QT. Safety and efficacy of different anesthetic regimens for parturients with COVID-19 undergoing Cesarean delivery: a case series of 17 patients. Can J Anaesth. 2020;67:655–663.
22. Benhamou D, Meyer HK, Morau E, Chassard D, Mercier FJ. French Obstetric Anesthesia Working G. Spinal anesthesia for Cesarean delivery in women with COVID-19 infection: questions regarding the cause of hypotension. Can J Anaesth. 2020;77:1–2.
23. Uppal V, Sondekkopav RM, Landau R, El-Boghdadly K, Narouze S, Kalaigara HKP. Neuraxial anaesthesia and peripheral nerve blocks during the COVID-19 pandemic: a literature review and practice recommendations. Anaesthesia. 2020;75:1350–1363.
24. Kinsella SM, Carvalho B, Dyer RA, et al. International consensus statement on the management of hypotension with vaso pressors during caesarean section under spinal anaesthesia. Anaesthesia. 2018;73(1):71–92.
25. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. PLoS One. 2012;7(4):e35797.
26. Kinsella SM, Girgirah K, Scuttton MJ. Rapid sequence spinal anaesthesia for category-1 urgent caesarean section: a case series. Anaesthesia. 2010;65(7):664–669.
27. Beckmann M, Calderbank S. Mode of anaesthetic for category 1 caesarean sections and neonatal outcomes. Aust N Z J Obstet Gynaecol. 2012;52(4):316–320.
28. McDonnell NJ, Paech MJ. General anaesthesia for emergency caesarean delivery: is the time saved worth the potential risks. Aust N Z J Obstet Gynaecol. 2012;52(4):311–312.
29. Interim Considerations for Obstetric Anesthesia Care Related to COVID-19. SOAP. 2020 Updated 4.6 https://soap.org/education/provider-education/expert-summaries/interim-considerations-for-obstetric-anesthesia-care-related-to-covid19/. Accessed 11 May 2020.
30. https://soap.org/education/provider-education/member-erac-consensus-statement-5-23-19-2/. Accessed 11 May 2020.
31. George RB, McKeen DM, Dominguez JE, Allen TK, Doyle PA, Habib AS. A randomized trial of phenylephrine infusion versus bolus dosage for nausea and vomiting during Cesarean delivery in obese women. Can J Anaesth. 2018;65(3):254–262.
32. Habib AS, George RB, McKeen DM, et al. Antiemetics added to phenylephrine infusion during cesarean delivery: a randomized controlled trial. Obstet Gynecol. 2013;121(3):615–623.
33. Lee JE, George RB, Habib AS. Spinal-induced hypotension: incidence, mechanisms, prophylaxis, and management: summarizing 20 years of research. Best Pract Res Clin Anaesthesiol. 2017;31(1):57–68.
34. Mireault D, Loubert C, Drolet P, et al. Uterine exteriorization during the COVID-19 pandemic. Am J Obstet Gynecol MFM. 2020;2(2):100118.
35. Zaphiratos V, George RB, Boyd JC, Habib AS. Uterine exteriorization compared with in situ repair of hysterotomy after cesarean delivery: a randomized controlled trial. Obstet Gynecol. 2020;135(5):1145–1151.
36. Mireault D, Loubert C, Drolet P, et al. Uterine exteriorization compared with in situ repair of hysterotomy after cesarean delivery: a randomized controlled trial. Obstet Gynecol. 2020;135(5):1145–1151.
37. Zaphiratos V, George RB, Boyd JC, Habib AS. Uterine exteriorization compared with in situ repair of Cesarean delivery: a systematic review and meta-analysis. Can J Anaesth. 2015;62(11):1209–1220.