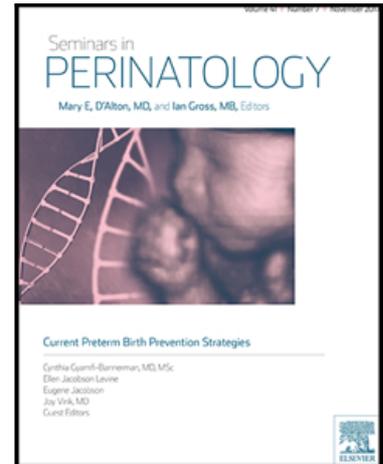


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What Obstetricians should know about Obstetric Anesthesia during the COVID-19 pandemic

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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.

“There are no emergencies in a pandemic.” -Colloquialism

“There were only emergencies in a pandemic, it turned out.” -Lili Loofbourow

Introduction

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.¹ 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.²

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.³ 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 than 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 $75,000 \times 10^6/L$ 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 rare and usually not severe,⁸ and prolongation of tests of coagulation have been reported.

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.¹ 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.⁹ 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.⁵ 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,¹⁰ 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.^{11,12} 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.¹³ Recommendations for antepartum thromboprophylaxis should follow institutional

guidelines (which may include unfractionated heparin 5000 units subcutaneous twice or three times daily).¹⁴ Provision of neuraxial analgesia/anesthesia in pregnant women receiving thromboprophylaxis should follow the SOAP Consensus statement.¹⁵

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 (Figure 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.

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.¹ An early publication from China posited that 'exaggerated' hypotension may occur with neuraxial anesthesia in women with SARS-CoV-2 infection.²¹ 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.²²

Supplemental oxygen should not be used unless specifically indicated ($SpO_2 < 95\%$ prior to delivery⁵ or $SpO_2 < 90\%$ or lower after delivery) as this is an aerosol generating procedure.²³ 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 $FiO_2 > 50\%$, moderate to severe acidemia, and/or the need for vasopressors) requires modifications 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 respiration 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 respiratory 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% - 12-15mg) and opioid adjuvants 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).²⁴ 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 management.

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 hemodynamic 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 respiration. 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.

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 communications 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. Because of the risk of caregiver exposure during an intubation, SARS-CoV-2 infection has forced a difficult reassessment of under what circumstances general anesthesia 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.²⁵ 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 positive, the anesthesia team will need to weigh the risk of general 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,²⁶ particularly in the setting of a difficult airway.²⁶ Even in the setting of fetal distress, the putative 2-3 minutes 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,^{27,28} 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.²⁹ 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.¹⁹ 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,²⁵ 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).³⁰ Particular emphasis should be on avoiding retching and vomiting as these are aerosolizing events.¹⁰ 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.³¹⁻³³

In addition, there is growing evidence that uterus exteriorization during cesarean delivery significantly increases intraoperative nausea and vomiting and should in general be avoided,^{34,35} but even more so in patients with SARS-CoV-2 infection.

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.⁵

Post-delivery period

For asymptomatic or mildly symptomatic patients, postoperative and post-delivery analgesia should be similar to that delivered to COVID-19 negative patients, including but not limited to ibuprofen, acetaminophen and neuraxial preservative-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), truncal 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 for emergent cesarean delivery whenever possible, the anesthesia team can contribute to creating a safer environment for all in Labor and Delivery Units.

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

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

1. All patients should be screened for COVID-19 symptoms (subjective or measured fever $\geq 37.8^{\circ}$, 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. Patients who present in middle column would move to right or left column with RT-PCR result.

*per local policy, may need repeated negative tests in order to be considered COVID-19 negative

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

Nebulizer administration
O ₂ administration (> 5L)
Retching or vomiting
Bag-mask ventilation
Non-invasive ventilation (CPAP, BiPAP)
Endotracheal intubation
Endotracheal tube suctioning
Endotracheal extubation

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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 epidural catheter
Low threshold for replacing questionable epidural catheters
Close and timely communication between obstetricians, anesthesiologists and nurses regarding changes in parturient or fetal status
Pre-cesarean huddles to communicate COVID-status (RT-PCR negative, PUI, RT-PCR positive)
Safe and timely transfers to the operating room if cesarean delivery is indicated

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 <ul style="list-style-type: none">- phenylephrine infusion- antiemetics (ondansetron, metoclopramide)- avoidance of uterine exteriorization
5. Multimodal opioid-sparing analgesia should be initiated as per ERAC protocols <ul style="list-style-type: none">- Acetaminophen 650mg q6h- Ibuprofen 600mg q6h (unless specifically contraindicated)- Oxycodone 5mg for breakthrough pain (maximum daily dose 30mg)

Figure 1. Operating room preparedness



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