



Practical considerations for performing regional anesthesia: lessons learned from the COVID-19 pandemic

Considérations pratiques pour la réalisation de l'anesthésie régionale: les leçons tirées de la pandémie de COVID-19

Sui An Lie, MBBS, MRCP, MMed · Sook Wai Wong, MBBS · Loong Tat Wong, MBBS, MMed, CHSE · Theodore Gar Ling Wong, MD, FRCPC · Shin Yuet Chong, MBBS (Hons), MMed, CHSE

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Abstract *Coronavirus disease (COVID-19) was declared a pandemic by the World Health Organization on 11 March 2020 because of its rapid worldwide spread. In the operating room, as part of hospital outbreak response measures, anesthesiologists are required to have heightened precautions and tailor anesthetic practices to individual patients. In particular, by minimizing the many aerosol-generating procedures performed during general anesthesia, anesthesiologists can reduce exposure to patients' respiratory secretions and the risk of perioperative viral transmission to healthcare workers and other patients. To avoid any airway manipulation, regional anesthesia should be considered whenever surgery is planned for a suspect or confirmed COVID-19 patient or any patient who poses an infection risk. Regional anesthesia has benefits of preservation of respiratory function, avoidance of aerosolization and hence viral transmission. This article explores the practical considerations and recommended measures for performing regional anesthesia in this group of patients, focusing on control measures geared towards ensuring patient and staff safety, equipment protection, and infection prevention. By doing so, we hope to address an issue that may have downstream implications in the way we practice infection control in anesthesia, with particular relevance to this new era of emerging infectious diseases and novel*

pathogens. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is not the first, and certainly will not be the last novel virus that will lead to worldwide outbreaks. Having a well thought out regional anesthesia plan to manage these patients in this new normal will ensure the best possible outcome for both the patient and the perioperative management team.

Résumé *Le 11 mars 2020, l'Organisation mondiale de la Santé déclarait que la nouvelle maladie du coronavirus 2019 (COVID-19) était une pandémie en raison de sa propagation mondiale rapide. En salle d'opération, dans le cadre des mesures de réponse aux épidémies, les anesthésiologistes doivent prendre des précautions supplémentaires et adapter les pratiques anesthésiques au cas par cas selon chaque patient. Plus particulièrement, en minimisant les nombreuses interventions générant des aérosols pendant la réalisation de l'anesthésie générale, les anesthésiologistes peuvent réduire l'exposition aux sécrétions respiratoires des patients et le risque de transmission virale périopératoire aux travailleurs de la santé et aux autres patients. Afin d'éviter toute manipulation des voies aériennes, il convient d'envisager la réalisation d'une anesthésie régionale si une chirurgie est prévue chez un patient sous enquête de COVID-19 ou confirmé, ou chez tout patient posant un risque infectieux. L'anesthésie régionale comporte des avantages en matière de maintien de la fonction respiratoire et ce, tout en évitant la production d'aérosols et par conséquent la transmission virale. Cet article explore les considérations pratiques et les mesures recommandées pour réaliser une anesthésie régionale dans ce groupe de patients, en se concentrant sur les mesures de surveillance visant à garantir la sécurité des patients et du personnel soignant, la protection des*

S. A. Lie, MBBS, MRCP, MMed (✉) · S. W. Wong, MBBS · L. T. Wong, MBBS, MMed, CHSE · T. G. L. Wong, MD, FRCPC · S. Y. Chong, MBBS (Hons), MMed, CHSE
Division of Anesthesiology and Perioperative Medicine,
Singapore General Hospital, Outram Road, Singapore 169608,
Singapore
e-mail: lie.sui.an@singhealth.com.sg

équipements et la prévention des infections. Ce faisant, nous espérons répondre à des interrogations qui pourraient avoir des implications à plus long terme dans la manière dont nous pratiquerons la prévention de la contagion en anesthésie, avec une pertinence toute particulière pour cette nouvelle ère de maladies infectieuses émergentes et de nouveaux pathogènes. Le coronavirus du syndrome respiratoire aigu sévère 2 (SARS-CoV-2) n'est pas le premier et ne sera certainement pas le dernier nouveau virus qui entraînera des épidémies mondiales. En disposant d'un plan bien conçu d'anesthésie régionale pour prendre en charge ces patients dans cette nouvelle ère, les meilleures issues possibles seront assurées tant pour le patient que pour l'équipe de prise en charge périopératoire.

Coronavirus disease, named officially by the World Health Organization (WHO) on 11 February 2020 as COVID-19,¹ emerged from Wuhan, China in early December 2019. Since then, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes COVID-19 has rapidly achieved effective and sustained human-to-human transmission via contact, droplet, and likely airborne routes.² The COVID-19 outbreak was initially labelled a “public health emergency of international concern”,³ but with more than 150,000 confirmed cases of infection, and 5,000 deaths globally⁴ at the time of writing, WHO declared COVID-19 a pandemic on 11 March 2020, triggering upscaling of emergency response mechanisms worldwide.⁵ Clinical presentation was varied, with most patients having respiratory tract symptoms.^{6–8} A study of 1,099 patients with COVID-19 showed that 19% presented with shortness of breath, 41% required oxygen supplementation, 5% became critically ill, and 2.3% required invasive mechanical ventilation.⁹ Singapore saw the first case of COVID-19 on 23 January 2020, with subsequent community spread linked to several infection clusters.^{10,11} Following this, the nation instituted a series of outbreak response measures aimed at containing and mitigating the risk of imported cases and community transmission. In hospitals, these included enhanced surveillance, administrative and environmental controls, environment hygiene, correct work practices, and appropriate use of personal protective equipment (PPE), in keeping with recommendations from the WHO¹² and the Centers for Disease Prevention and Control.¹³

As anesthesiologists at the front line of the management of surgical patients, and with the rapidly increasing number of COVID-19 cases worldwide, we can expect to encounter more of these patients (or patients with other emerging

viral pathogens in future) presenting for surgical intervention. To make matters worse, as there are unconfirmed reports of transmission before symptoms manifest, it may be challenging to identify and isolate patients carrying the virus before deciding to institute appropriate precautions. As with previous outbreaks such as severe acute respiratory syndrome (SARS), influenza A (H1N1) 2009 infection, and the Middle East Respiratory Syndrome, this would require heightened precautions and tailoring our anesthetic practice to reduce exposure to patients' respiratory secretions and the risk of perioperative viral transmission to healthcare workers and other patients.^{14–16} In particular, this should involve minimizing the many aerosol-generating procedures we perform during general anesthesia (GA), such as bag mask ventilation, open airway suctioning, and endotracheal intubation. During the SARS outbreak, intubation was one of the independent risk factors for super-spreading nosocomial outbreaks affecting many healthcare workers in Hong Kong and Guangzhou, China.¹⁷ As such, some considerations during airway management of confirmed/suspected COVID-19 patients have been suggested to reduce the risk of nosocomial viral transmission.^{12,13,18} Nevertheless, to avoid any airway manipulation, the use of regional anesthesia (RA) techniques (e.g., peripheral nerve blocks and/or central neuraxial blocks) may be preferred.¹⁹

Other than the general benefits of reduced pain and opioid consumption, postoperative pulmonary complications, postoperative nausea and vomiting, and possibly postoperative cognitive dysfunction and delirium offered by RA over GA (with systemic opioids),²⁰ the main advantage in patients with infectious respiratory viral diseases would be the avoidance of airway instrumentation and patient coughing during intubation and extubation,^{21,22} thus reducing the risk of infecting staff via the associated aerosol generation and dispersion of viral particles.²³ Secondly, and broadly speaking, RA has fewer effects on respiratory function and dynamics compared with GA with or without muscle paralysis.^{24–26} This relative preservation of respiratory function could theoretically reduce postoperative pulmonary complications in COVID-19 patients who may already have reduced respiratory function from COVID-19-associated pneumonia or acute respiratory distress syndrome.

Given the above logical advantages of RA over GA in managing patients with infectious respiratory viral diseases such as COVID-19 and the paucity of literature on this aspect, this narrative review aims to explore the practical considerations and recommended measures for performing RA in this group of patients, focusing on control measures geared towards ensuring patient and staff safety, and infection prevention. By doing so, the authors hope to

address an issue that may have downstream implications in the way we practice infection control in anesthesia, particularly in this era of emerging infectious diseases and novel pathogens. A description of control measures taken in the hospital²⁷ and nationwide to contain and mitigate the spread of COVID-19 is beyond the scope of this article.

Practical considerations and suggested solutions

Preparation phase: prior to performing RA

INTRA-HOSPITAL TRANSPORT

Transporting a COVID-19 patient from an isolation ward to the operating room (OR) presents opportunities for contaminating both the environment and personnel. At our institution, patients wear a surgical face mask during transfer from the isolation ward to the OR, and the accompanying healthcare workers wear fitted, National Institute of Occupational Safety and Health-certified N95 respirators, eye protection (either goggles or full face shield), caps, gowns, and gloves.¹³ We transport these patients along a designated route to minimize contact with other people, in the presence of an infection prevention nurse and security personnel to prevent environmental contamination and ensure compliance with infection control measures.

PREOPERATIVE ASSESSMENT

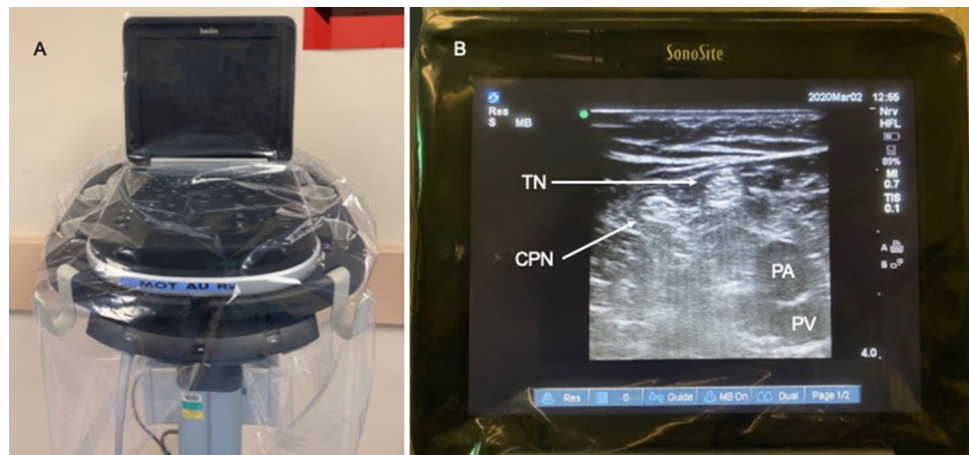
Consent-taking is still largely paper-based in our institution. This may lead to potential paper contamination during the process of consent-taking. A possible solution would be to use digital consent forms signed on laptops or mobile devices, which can be protected with single-use plastic wraps.

PREPARATION OF OR AND EQUIPMENT

The patient should be reviewed, blocked, and recovered inside the OR where surgery will be performed to limit contamination to a single location. The number of personnel within the OR should be kept to a minimum. Only necessary equipment and drugs required should be brought into the OR to prevent contamination and wasting resources (as unused consumables will be discarded at the end of the operation).^{28,29} Additional equipment required that was initially unanticipated can be obtained through a “runner”. This is usually a dedicated anesthetic trained nurse in our institution. As far as possible, single-use equipment should be selected.

The ultrasound machine has a large footprint and numerous surfaces that can harbor droplets thus serving as reservoirs for the virus if proper protection or decontamination processes are not followed.³⁰ In our institution, to prevent contamination of the ultrasound machine but still be able to obtain satisfactory images, the ultrasound machine’s screen and controls are protected with a single-use plastic cover (Fig. 1). Additional ultrasound probes that are not needed for the block should be detached from the machine to minimize areas for potential contamination. The ultrasound probe that comes into contact with the patient should be covered along its entire length with a disposable probe sheath. The probe sheath in our institution is too short to cover the entire length of the probe, so we cut off one end of a sheath to form a tube and slide it over the probe to cover the proximal half, and then use another (sterile) sheath to cover the distal half so that no part of the probe will come in direct contact with the patient (Fig. 2). This facilitates cleaning after the procedure. Alternatively, portable handheld point-of-care ultrasound devices can be considered, given that their smaller size will make decontamination much easier post-procedure. Pre-

Fig. 1 A) The ultrasound machine’s screen and controls are protected with a single-use plastic cover to prevent contamination and to ease disinfection post-procedure. B) Despite being covered in plastic, we were still able to obtain satisfactory images for a popliteal nerve block. CPN = common peroneal nerve; PA = popliteal artery; PV = popliteal vein; TN = tibial nerve.



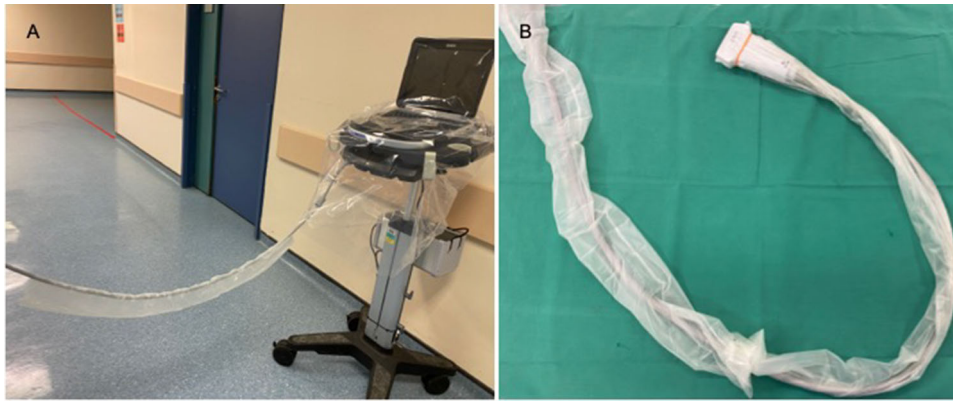


Fig. 2 The ultrasound probe is covered with a disposable sheath along its entire length so that any part of the probe that potentially may come in contact with the patient is protected. Depending on the type of sheath available, it may need to be extended with the use of more than one sheath. A) For example, the probe sheath in our

institution is too short to cover the entire length of the probe, so we cut off one end of a sheath to form a tube and slide it over the probe to cover the proximal half, and then B) use another (sterile) sheath to cover the distal half.



Fig. 3 Set up of capnography monitoring. A) The 15-mm endotracheal tube connector together with a heat and moisture exchanger/filter are connected to the simple face mask. The carbon dioxide (CO₂) sampling line is then connected to the heat and

moisture exchanger. B) In an alternative set up, a cut section of a suction catheter is interposed between the simple face mask and the endotracheal tube connector. C) Both setups allowed us to obtain CO₂ tracing and monitor respiratory movements.

scanning with an unprotected ultrasound probe should be avoided to prevent probe contamination.

Intraoperative phase: performance of RA

SEDATION

Sedation should be used with caution in COVID-19 patients as they may have co-existing respiratory compromise from COVID-19 pneumonia. Oxygenation and ventilation should be closely monitored if the patient is sedated. Although it is recommended that carbon dioxide (CO₂) monitoring should be immediately available for any patient undergoing sedation,³¹ one should avoid connecting the CO₂ sampling line directly so as to prevent contamination of the patient monitor. Instead, we improvise by connecting a 15-mm endotracheal tube (ETT) connector and a high-efficiency particulate air

(HEPA) heat and moisture exchanging (HME) filter either directly to the simple face mask or interposed by a cut segment of suction tubing. The CO₂ sampling line is then connected to the HEPA HME so that sampled gas is filtered and a CO₂ tracing can be obtained to monitor respiratory rate (Fig. 3). Alternatively, the respiratory rate can be monitored by clinical observation and assessment by a vigilant anesthesiologist or by electrocardiogram systems that use impedance plethysmography.

Oxygen therapy was identified as an independent risk factor for super-spreading nosocomial outbreaks of SARS in Hong Kong and Guangzhou, China.¹⁷ Extrapolating from these lessons, the patient should wear a surgical face mask at all times to prevent droplet transmission. Oxygen supplementation via venturi mask, non-invasive positive pressure ventilation, and high-flow nasal cannula such as the transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) should be avoided to prevent risk of

aerosolization and subsequent cross infection.^{13,15,32,33} If needed, supplemental oxygen can be delivered via nasal prongs under the surgical face mask to reduce dispersion of exhaled air posing an infectious risk.³⁴ If using a simple face mask, flow of oxygen should be kept as low as needed to maintain oxygen saturation. Hui and colleagues showed that dispersal distances of exhaled air increased with increasing oxygen flow rates (lateral distances of 0.2, 0.22, 0.3, and 0.4 m from the sagittal plane during the delivery of oxygen at 4, 6, 8, and 10 L·min⁻¹ respectively).³⁵ Coughing can extend the dispersion distance further, posing an infectious risk to surrounding healthcare workers at a short distance away. Since substantial exposure to exhaled air occurs generally within 0.4 m from the patients receiving supplemental oxygen via a simple mask, healthcare workers should take appropriate respiratory precautions and observe the principles of safe oxygen delivery.

PERSONAL PROTECTIVE EQUIPMENT AND ITS CHALLENGES

Operators performing RA on a COVID-19 patient should, at minimum, don PPE, goggles, and a surgical face mask.¹³ The option of donning an N95 respirator or powered air purifying respirator (PAPR) is at the discretion of the proceduralist as RA is not an aerosol-generating procedure. The physical encumbrance of PAPR may be associated with reduced peripheral vision and auditory acuity, leading to impaired communication between team members, decreased mobility, restricted view, and heat stress in healthcare providers. The combination of these factors can affect concentration and hence performance of RA techniques.^{36–39} The execution of the nerve block may also be impaired by the proceduralist's unfamiliarity with using PPE during the procedure, and the time to do the block may thus be prolonged.

ASSESSMENT OF ADEQUACY OF RA

Reusable cooling blocks used to assess adequacy of RA techniques may be a source for contamination. As such, they should be placed in disposable plastic bags to prevent contamination, which can then be removed using a non-touch technique. The cooling block used should be cleaned with quaternary ammonium chloride disinfectant wipes thereafter.⁴⁰ Alternatively, ice cubes can be placed in a disposable plastic bag and used instead of a reusable cooling block. These can then be discarded after a single use.

Postoperative phase

RECOVERY OF PATIENT

After the surgical procedure, the patient should remain in the same OR for post-anesthetic recovery to prevent contamination of other clinical areas.

DECONTAMINATION OF EQUIPMENT

The plastic sheets covering the ultrasound machine should be removed and discarded in clearly labelled biohazard bins. The ultrasound machine should be wiped down with quaternary ammonium chloride disinfectant wipes.⁴⁰ It should then be left in the OR for ultraviolet C irradiation or hydrogen peroxide vaporization before it is used on another patient.

Managing complications related to RA technique

FAILED BLOCK

Prior to the start of surgery, the block should be tested to ensure optimal operating conditions so as to avoid urgent conversion to GA when surgery is already underway. Anesthesiologists may be pressed to hastily don PAPR and convert to GA, increasing the risk of an inadvertent breach of infection control. Therefore, the anesthesiologist may choose to don PAPR (or similar PPE used for intubation) even when performing the block so as to be able to respond to intraoperative emergencies in a timely yet safe manner. Should the need to convert to GA arise, the anesthesiologist should follow PPE guidelines and use an induction technique that reduces aerosol generation to the minimum.^{13,15,29,41}

LOCAL ANESTHETIC SYSTEMIC TOXICITY (LAST)

If the patient develops signs and symptoms of LAST, a crisis should be declared and help summoned early as time is needed for additional personnel to be appropriately protected with PPE/PAPR before entering the resuscitation.⁴¹ Management of LAST should follow current established guidelines.⁴² The anesthesia drug trolley containing the standard resuscitation drugs and defibrillator cart should then be pushed in for use in patient resuscitation. In our institution, we have reduced the drugs kept in the drug trolley to minimize unnecessary wastage. A “runner” stationed outside the OR for all cases is responsible for replenishing drugs and equipment that are not found in the trolley.

Potential complications specific to brachial plexus blocks include pneumothorax and phrenic nerve involvement causing diaphragmatic paralysis that may cause further respiratory compromise in the COVID-19 patient. The most experienced operator should perform the block and the needle tip should always be visualized to prevent a pneumothorax. Diaphragmatic paralysis occurs because of the inhibitory effects of local anesthetics on the phrenic nerve or its nerve roots from C3–5. Various methods can be adopted to minimize the occurrence of diaphragmatic paralysis. These include modifying the local anesthetic dose via volume and concentration or the injection site and technique in an interscalene block, or performing an entirely different RA technique such as a suprascapular or infraclavicular block instead.⁴³

Discussion

The aim of this article is to present a useful and easily accessible guide for the anesthesiologist who would like to perform RA for suspect or confirmed COVID-19 infected patients coming for surgery. Although we have not yet been able to study the effectiveness of our proposed

strategies (as we have yet to perform RA in a confirmed COVID-19 infected patient), we have recently performed a supraclavicular nerve block on a patient at risk of COVID-19 infection due to positive travel history, and popliteal nerve block in another patient with known coronavirus OC43 viral infection. The coronavirus OC43 is a member of the *Coronaviridae* family known to cause acute upper respiratory tract infections. It is spread by droplet transmission, similar to SARS-CoV-2 and other respiratory viruses.⁴⁴ In this case, we thought through the considerations beforehand and adopted the suggested protective measures (Fig. 4). So far, none of the perioperative management team members developed any upper respiratory tract infection symptoms in the subsequent two weeks.

The isolation OR workflow and clinical care guidelines are institution- and department-specific, so our recommendations for the possible challenges may not be applicable to all healthcare facilities. Furthermore, the level of expertise in RA techniques may vary between institutions, so GA may be the default technique of choice in some hospitals. Nevertheless, we believe that our article fills an important void in the literature and presents important considerations when performing RA for such patients.

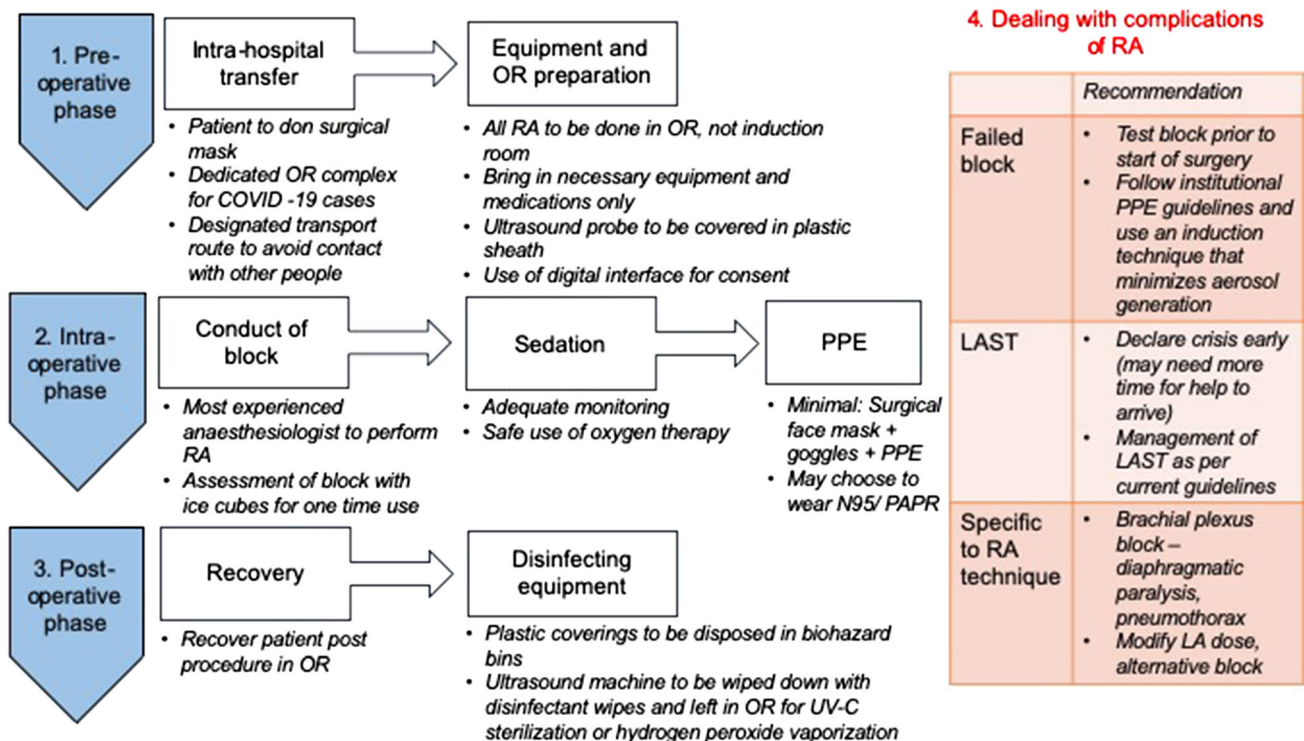


Fig. 4 A summary of considerations and practical recommendations aimed at ensuring patient and staff safety, and infection prevention during regional anesthesia for patients with coronavirus disease (COVID-19) infection or infection with other infectious respiratory viral diseases.

Anesthesia providers for these patients should be well-versed in both GA and RA techniques. In our institution, the most senior member of the on-call anesthesia team (attending grade) is the primary anesthesiologist for suspect or confirmed COVID-19 infected patients. The technique selected should be one that is best suited for the patient and type of surgery, with the least risk of viral transmission to the perioperative management team.

Conclusion

Because it preserves respiratory function and avoids aerosolization and hence viral transmission, RA should be considered whenever surgery is planned for a suspected or confirmed COVID-19 patient. The practical considerations and recommendations covered in this article can therefore be applied to all patients who pose a similar infectious risk, not just those with COVID-19 infection. The SARS-CoV-2 virus is not the first and certainly will not be the last novel virus to achieve worldwide outbreaks. Having a well thought out RA plan to manage infected patients in this new normal will ensure the best possible outcome for both the patient and the perioperative management team.

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