Regional anesthesia in coronavirus disease 2019 pandemic

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Purpose of review
Coronavirus disease 19 (COVID-19) has presented numerous challenges to healthcare systems worldwide. The virus is highly contagious and infectious since transmission can occur via multiple routes. General measures to prevent viral transmission to patients and healthcare personnel, such as a reduction in clinical load and routine testing, must be coupled with multiple additional safety measures in perioperative services.

Recent findings
Regional anesthesia preserves respiratory function and reduces aerosol-generating procedures typically associated with airway management in general anesthesia, making it the first choice for a suspected or confirmed COVID-19 patient in need of surgery with anesthesia. A well thought out regional anesthetic plan, implementation of hygiene and (personal) safety measures are necessary to ensure the best possible outcome for both the patient and the healthcare staff.

Summary
The present review addresses both practical and recommended measures for performing regional anesthesia in the pandemic, to ensure patient and staff safety, and equipment protection. Further research and evidence-based guidelines are necessary to devise an established standard of care during the current COVID-19 and possible future pandemics.

Keywords
coronavirus disease 2019, personal protective equipment, regional anesthesia, surgery, viral transmission

INTRODUCTION

Coronavirus disease 19 (COVID-19) has presented numerous challenges to healthcare systems worldwide. This may continue for months and possibly years. The threats that the disease poses to both patients and healthcare workers have changed medical practice. COVID-19 caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV2) is highly contagious (basic reproduction number, R0: 2–2.5), and has spread so rapidly that it overwhelmed the healthcare capacities worldwide [1]. This has created disruptions in global medical supply chains, delivery of medical care, and temporary cessation of elective surgeries.

The present review addresses both practical and recommended considerations and recommended measures for performing regional anesthesia in the pandemic. It focuses on regional anesthesia-based strategies for patient and staff safety, and as well as equipment protection. Of note, while some of the opinions and practical examples in this opinion are specific to our institutional practice, they are highly practical and pragmatic examples that can be reproduced elsewhere, if deemed applicable. Additional research and evidence-based guidelines are necessary to devise a more universal standard of care during the current covid-19 and possible similar future pandemics.

CLINICAL PRESENTATION

Clinical features of COVID-19 include history suggestive of respiratory infections, such as fever, cough, with or without expectorations, myalgia, sore throat, and a range of various symptoms, such as anosmia, dermatological lesions, ocular manifestations, hypertension, stroke, and acute

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KEY POINTS

- Coronavirus disease 2019 (COVID-19) is highly infectious and contagious via contact and fomites, droplet and airborne transmission.
- Broad spectrum of disease presentation from asymptomatic to mild upper airway symptoms to multiorgan dysfunction.
- Personal protective equipment is essential in infection prevention in healthcare personnel and possible nosocomial spread amongst patients.
- Regional anesthesia is the first choice in anesthetic technique when possible in a patient with (suspected) COVID-19 infection.

coronary events [2]. Multiorgan system involvement is dependent on the speed of viral replication, and host immune responses. The presence of ACE2 downregulation or shedding results in dysfunction of the renin–angiotensin system and increased pulmonary vascular permeability. The overactivation of T cells and antibody-dependent enhancements result in the systematic inflammatory response, cytokine storm, adult respiratory distress syndrome, and multiorgan dysfunction syndrome [3▪▪]. Therefore, the clinical presentation of patients in need of anesthesia and surgery comprises a broad spectrum of disease presentation from asymptomatic, to mild upper airway symptoms, to intensive care support with extracorporeal membrane oxygenation.

The definitive diagnosis of COVID-19 is made using nucleic acid tests, such as real-time reverse transcription polymerized chain reactions (rtPCR; <5% false negative). Rapid serological tests with immunoglobulin M (IgM) and IgM antibody testing result in a high incidence of false-negative tests (10–15%) [4]. Regardless, antibody testing can be useful when planning for emergency surgeries in patients who are rtPCR negative, but have a high clinical index of suspicion. In limited resources or emergent nature of the needed treatment, patients are best managed as 'clinical suspects' with full precautions as for confirmed cases of COVID-19.

CORONAVIRUS DISEASE 2019 TRANSMISSION AND ANESTHESIA CONSIDERATIONS

SARS-CoV-2 is primarily spread via respiratory droplets and aerosol, and via direct patient contact or fomites (materials and equipment which carry infection, such as clothes). Droplet spread is limited by gravity to <2 m, whereas aerosol-generating procedures, such as coughing and sneezing, result in a more distant spread of the virus. This distant spread remains airborne for a longer time and is considered to be particularly contagious and infectious. The virus can be isolated by swabbing objects in proximity of patients such as doorknobs and clothes for as long as 2–3 weeks [3▪▪]. Water fountains and sinks around patients are often the common sources of virus transmission.

Caution should also be exercised when there is a potential for fecal contamination, as this is another route of viral transmission. Defecation sometimes occurs with sympathetic blocks after subarachnoid anesthesia is performed. Thorough cleaning of patients and rolling of diapers is best done with disposable plastic cover films and minimum number of personnel in the treatment area [3▪▪].

Aerosol-generating procedures such as endotracheal intubation and coughing during extubation in a patient with an acute respiratory infection has a 6.6 times higher chance of infecting healthcare professionals [5]. Avoiding airway management altogether with regional anesthesia intuitively should decrease the exposure of the operating room (OR) staff. However, it is possible that even talking and breathing, may also generate aerosols, A study from China in a small cohort of anesthetists providing neuraxial anesthesia to patients with known COVID-19 [6] demonstrated that COVID-19 infection was statistically more likely in those anesthetists who had not worn self-contained breathing apparatus and a fully encapsulating protective suit. Additional factors that may pose a risk of COVID-19 transmission during surgery under regional anesthesia could be the proximity of the healthcare providers to the patient, duration of exposure, and whether the patient is actively ill with COVID-19 symptoms.

It has been well established that regional anesthesia is associated with better outcomes for a number of specific surgical procedures and patients groups. These benefits may include reductions in postoperative pulmonary complications, nausea and vomiting, cognitive dysfunction, and delirium. The relative preservation of respiratory function may reduce postoperative pulmonary complications especially in patients with COVID-19-associated pneumonia or acute respiratory distress syndrome. The American Society of Regional Anesthesia and Pain Medicine and the European Society of Regional Anesthesia and Pain Therapy have recently published a joint statement on practice recommendations for use of regional anesthesia during the COVID-19 pandemic. This review focuses on the role of modern regional anesthesia in the current

COVID-19 epidemic, and the possible similar future pandemics.

PROTECTION OF THE ANESTHESIA AND OPERATING ROOM PERSONNEL

As the virus may be transmitted even from asymptomatic carriers scheduled for surgery, routine patient testing before surgery is the first step in general strategy to protect healthcare personnel from infection and a possible nosocomial spread among patients [7▪▪]. The number of personnel present during the performance of the procedure should be minimized, and help (e.g., a 'runner') should be readily available.

There are three levels of personal protection standards which are based on the mechanism and risk of the viral spread. Protection from the objects or materials which are likely to carry infection, such as clothes, utensils, and furniture, is best fulfilled with fluid-resistant gloves and gowns. However, droplet precautions are more challenging and additionally require face shields, fluid-resistant face masks, and goggles. Airborne risk preventions include respirator masks, such as N95 (N-not resistant to oil; 95% protection against 0.3 μm particles) or FFP2/3 (European union standards: filtering facepiece effective against 94% particles – FFP2 and 99% particles – FFP3). Powered air-purifying respirators (PAPR) in addition to all droplet precautions can also be used in 'very high aerosol risks' where the trajectory of exhaled viral expulsions is higher [8]. Clinical examples of these situations are intubation, particularly during resuscitation, handling restless patients, or working in the vicinity of ill-fitting face helmets or noninvasive ventilation equipment with large leaks. The donning of PPE should occur before entering the room. The presence of an observer during the donning and doffing procedure is highly recommended. Simulation sessions should be conducted for training staff in donning and doffing of PPE [9].

Care of suspected and confirmed COVID-19 patients should preferably be provided in a negative pressure room. This includes regional anesthesia performance and recovery time to reduce the risk of cross infection [7▪▪]. Five operating room air exchanges should eliminate the aerosolized matter, although complete elimination cannot be guaranteed. Limiting the period of close proximity between patient and anesthesia provider is possible during successful regional anesthesia. All patients should wear protective masks perioperatively, and avoid high flow oxygen therapy devices where possible. During the operation, the surgical drapes provide a physical barrier between the patient and surgical team. However, the surgical drapes do not offer barrier benefits to the anesthesia providers. When possible such a barrier can be added by using a clear plastic drape that allows direct patient monitoring and avoids claustrophobia. Alternatively, during a successful regional anesthetic, the anesthesia providers can monitor the patient at a distance or outside the operating room to minimize the number of staff members exposed.

In our practice at NYSORA, we routinely use the full protective equipment when providing regional anesthesia to COVID-19 positive patients (Fig. 1), although COVID-19 guidance is often pragmatic, rather than data-driven [10].

REGIONAL ANESTHESIA TECHNIQUES, EXPERIENCE AND TRAINING

Adequate training and experience is a logical prerequisite for the successful use of reliable and efficient surgical regional anesthesia in COVID-19 patients. The often-voiced concern is that increased utilization of regional techniques may result in block failures and the need for conversion to general anesthesia, exposing the entire scrubbed operating room staff to the aerosolized viral load. However, during the pandemic, only the experienced practitioners should perform the standardized regional anesthesia procedures and guide the intraoperative patient management. This approach is similar to the recommendations on airway management in COVID-19 patients. Experimental, newer techniques should be de-emphasized; instead, standardized techniques with high success rates should be used. In our institution at Ziekenhuis Oost-Limburg (ZOL) in Genk, Belgium, the entire regional anesthesia service and the assistants adhere to the

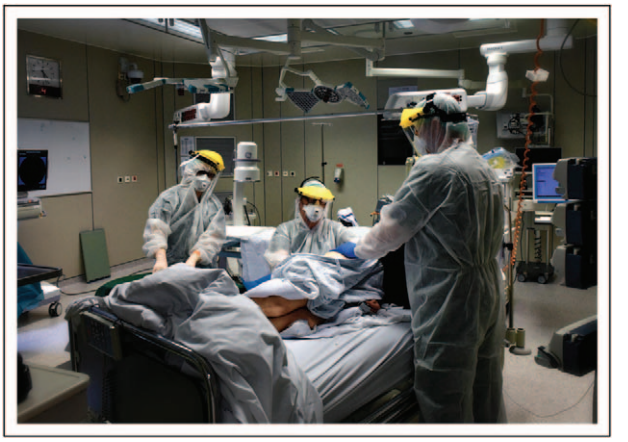

FIGURE 1. Full protective equipment during performance of regional anesthesia in a patient with active COVID-19 infection – spinal anesthesia for hip fracture. COVID-19, coronavirus disease 2019.

techniques and patient management algorithms outlined online at the NYSORA's Compendium of Regional Anesthesia at the NextLevelNYSORA (https://nextlevelcme.com/, last accessed 16 May 2021). The compendium, accessible online to all staff and faculty, details standardized regional anesthesia protocols, techniques, equipment and local anesthetic choices for specific surgical indications. This standardization has been particularly useful during the COVID pandemic, to minimize the outcome variability and enhance utilization of regional anesthesia.

PLANNING AND PREPARATION FOR REGIONAL ANESTHESIA

During the pandemic, the clinical load should be reduced to urgent and semi-urgent elective surgeries. Reducing the volume of surgical procedures allows for better planning for a surge of patients with COVID-19, and preservation and availability of protective equipment, as well as managing the staffing needs. This is important because unwell or infected healthcare workers will be quarantined [11]. At ZOL, the NYSORA's EUROPE center of excellence, we have substantially reduced clinical load and operate primarily on patients in whom significant delay of the procedure may increase the chance or degree of disability. As an example of the latter are patients with severe symptoms related to carpal tunnel syndrome or patients requiring ulnar nerve decompression and transfer. These patients routinely and mandatory receive regional anesthetics for their surgeries. All patients are subject to routine testing as per national guidelines, primarily consisting of nasal swab test and PCR (polymerase chain reaction), and absence of any clinical symptoms with even remote possibility of COVID-19 infection (e.g., fever).

For the PCR negative patients (test within 24 h), neuraxial anesthesia and peripheral nerve blocks are the first choice for anesthetic management of all patients and mandatory for orthopedic surgery patients having extremity surgery who are suspected to have COVID-19 infection. If the community spread of COVID-19 infection is large, even asymptomatic patients should be presumed to be COVID-19 positive when the test results are pending or unavailable [9].

Anesthesia for the COVID-19-infected or suspected patients is best provided in the operating room or in an airborne infection isolation room. Airflow from the operating room into the common areas must be prevented by ventilation and a negative pressure in the therapeutic areas. Operating rooms have a higher air exchange rate compared with hospital wards or floors. A standard operating room has a minimum of 15 air exchanges per hour, which removes 99% and 99.9% of airborne contaminants. The use of common areas, such as a block room or a holding area, should be avoided to reduce the risk of cross infection, unless these also have a provision for negative airflow and rapid air exchange. Ideally, record keeping or electronic recordings should be done outside the room [7▪▪].

PATIENT MANAGEMENT DURING ADMINISTRATION AND MANAGEMENT OF REGIONAL ANESTHESIA

The informed consent procedure should be exercised in the same way as in non-COVID-19 times. Healthcare should always be practiced in the patient's best interest, and medico-legal consequences of suboptimal care will not be exempt even in the current pandemic circumstances [12▪].

Preoperative evaluation to assess the extent of COVID-19 disease severity should be performed when possible in addition to routine preoperative risk stratifications. Anesthetic plan in a COVID-19-infected patient will depend on the degree of respiratory compromise, level of hemodynamic stability and presence of specific organ dysfunction, this will be in function of risk–benefit balance in each patient.

COVID-19 is often associated with thrombocytopenia, therefore the platelet count should be reviewed preoperatively. Thrombocytopenia may prevent the use of a deep nerve block, catheter techniques or neuraxial anesthesia. Assuming a normal platelet function, a platelet count above 75 000 is acceptable for most aforementioned regional anesthesia procedures [13]. The use of neuraxial anesthesia in the presence of systematic infection is often debated. However, small case series in covid positive patients (in the absence of neurologic signs or symptoms or other formal contraindications to neuraxial anesthesia) suggest that neuraxial anesthesia should be safe with regards to the risk of causing meningitis/encephalitis [12▪].

Patient preparation and asepsis should be similar to the existing institutional practices. The block selection should aim at minimal interference with respiratory function in patients who have respiratory involvement. As an example, an axillary or infraclavicular brachial plexus block may be chosen over an interscalene or supraclavicular brachial plexus block.

Sedation should be used carefully. We recommend avoiding premedication that may result in respiratory depression and the need for airway

intervention. Instead, we utilize small doses of ketamine-S and midazolam for patient comfort. This combination provides adequate analgesia and is devoid of the risk of respiratory depression or coughing.

Supplemental oxygen administration during anesthesia and surgery can result in exhaled air jets, and formation of airborne infectious aerosols. The type of oxygen therapy, viral load during breathing and talking; ventilation and air exchange in the room, and the use of facemask by the patient all influence the risk. While some of these factors cannot be controlled, the type of oxygen therapy determines the travelling distances of the exhaled air, and it can be controlled. The smallest travel distance (about 0.4 m) occurs with the use of a Hudson mask utilizing 4 l/min of O_2 flow. With a nasal cannula and 5 l/min, the particles can travel about 1 m [14]. Therefore the flow of oxygen should be kept to a minimum with a purpose to maintain saturation and minimize aerosol generation. At NYSORA, we apply the O_2 mask over the face mask (Fig. 2).

Communication within the team when dressed in full barrier protective clothing layers and head protective gear is difficult. Wireless communication systems and whiteboards can be used to communicate the needs in the operating room during the management of a COVID-19 patient with the staff assisting outside. In our center, we maintain communication with the outside 'runner' via a microphone inside (e.g., a baby monitor would do) to eliminate the use and contamination of the institutional telephones or mobile devices that could serve as a fomite (Fig. 3).

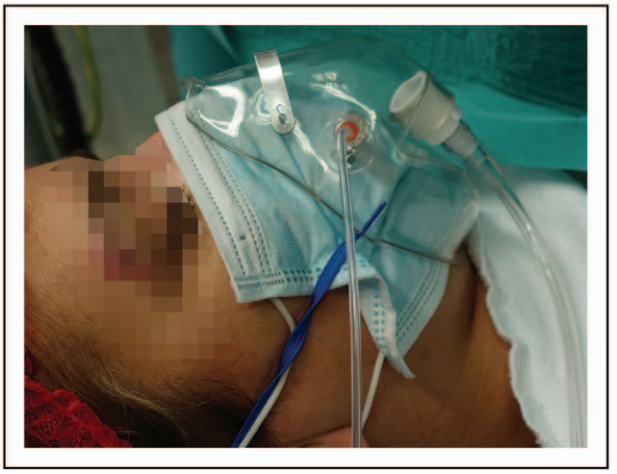

FIGURE 2. Oxygen mask with 4 l/min flow is shown applied over the surgical mask to decrease the risk of aerosolization. COVID-19, coronavirus disease 2019.

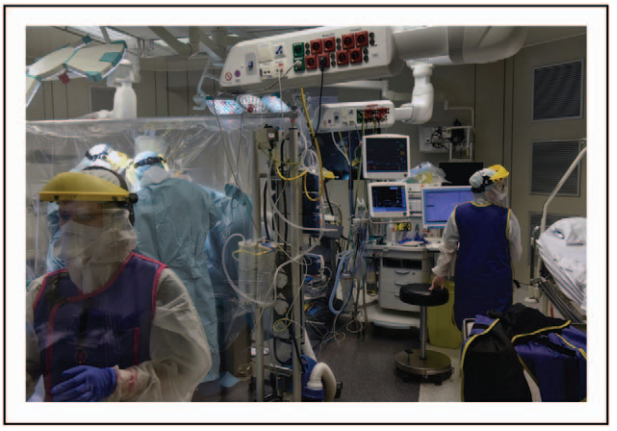

FIGURE 3. Hip fracture surgery in a COVID-19 positive patient. Note the minimal staffing and equipment in the operating room and plastic drapes as barriers between the patient and healthcare providers. Also, the patient's contaminated transport bed is kept in the operating room for the transfer to and from the operating room to avoid cross-contamination. COVID-19, coronavirus disease 2019.

In the case of block failure or surgical complications an early conversion to general anesthesia is advised. This usually allows more controlled conditions, possible rapid sequence induction to avoid bag masking. Full protective gear for all OR personnel is required.

After the conclusion of the surgical procedure, patients having regional anesthesia can bypass the recovery room and should be transported directly to their designated airborne infection isolation room. Bypassing the recovery room (PACU) substantially facilitates the logistics of the patient flow and management during the pandemic. Transporting a COVID-19 patient from an isolation ward to the OR presents opportunities for contaminating both the environment and personnel. Patients should wear a surgical face mask during transfer from the isolation ward to the OR and transport should be along a designated route to minimize contact with other people and equipment to prevent environmental contamination [15▪]. The transport personnel and the accompanying healthcare providers should wear well fitted N95 respirators. During patient care and transport, eye protection (either goggles or full face shield), caps, gowns, and gloves should be used.

EQUIPMENT PROTECTION DURING REGIONAL ANESTHESIA

During the pandemic, it is advisable to minimize the number of equipment items inside the operating

room. Only the essential equipment should be provided. Likewise, the equipment should be protected with disposable plastic covers during the procedure. The necessary equipment and medications for immediate perioperative care can be prepared and packed in a plastic zipper bag [16]. The ultrasound machine should be fully protected from contamination with plastic covers. Likewise, the ultrasound probes should be fully covered in long probe covers; the wound dressings or short covers are not adequate for protection. Handheld ultrasound devices, where applicable, may be preferable to larger machines due to ease of protection, and decontamination. Once utilized, regional anesthesia carts with equipment and medications, and ultrasound machines should not be brought back to the block room, but should be left confined to the treatment room, unless thoroughly decontaminated.

Table 1. Safe practice of regional anesthesia (RA) during COVID-19 pandemic

Protection of the anesthesia and operating room personnel
Routine patient testing
Reduce clinical load
Use appropriate personal protection equipment (PPE)
Minimal personnel inside the room
Use 'runner' personnel for help outside the OR
Preparation for regional anesthesia
Prepare and pack required medications in plastic bags
Assess covid disease severity and implications for anesthesia (e.g., trombopenia)
Discuss informed consent and risk–benefits with patient
Regional anesthesia techniques
Anesthesia is best provided in the operating room (or an airborne infection isolation room)
Experienced practitioners & standardized procedures with high success rate
Consider adjuvants & liposome bupivacaine to prolong nerve blocks for analgesia, where indicated
Patient management
Use minimal supplemental oxygen administration, best via FM, 4 l/min
For premedication and intraoperatively - choose medications with low risk of respiratory depression
Patients should wear surgical face masks at all times
Equipment protection
Only essential equipment in the room
Use disposable transparent covers to protect equipment (e.g., ultrasound)
Meticulous decontamination after use to prevent cross infection

COVID-19, coronavirus disease 2019; FM, face mask; OR, operating room.

CONCLUSION

COVID-19 outbreak has rapidly spread worldwide and overwhelmed the healthcare capacities worldwide. The clinical presentation of patients can comprise a broad spectrum of disease presentation from asymptomatic to mild upper airway symptoms to intensive care support. The threats that the disease poses to both patients and healthcare workers have substantially changed perioperative medical practice. Regional anesthesia is preferred over general anesthesia whenever possible because it preserves respiratory function and avoids aerosolization and hence viral transmission to other patients and healthcare workers. We reviewed current recommendations for perioperative care during COVID-19 pandemic and present a synthesis of the published information and our institutional practical implementation in caring for patients with active COVID-19 infection in need of surgery and anesthesia. A well thought out anesthetic plan in combination with the implementation of routine extensive hygiene and (personal) safety measures ensures the best possible outcome for both the patient and the perioperative management team (Table 1).

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Conflicts of interest

There are no conflicts of interest.

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