

Review Article

Emergency neurological procedures during COVID-19 pandemic: Practical issues

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Abstract

The novel coronavirus disease 2019 (COVID-19) has emerged as a global pandemic. A significant number of these patients would present to hospitals with neurological manifestations and neurosurgical emergencies requiring urgent treatment. The anesthesiologists should be prepared to manage these cases in an efficient and timely manner in the operating room, intensive care units, and interventional neuroradiology suites. The clinical course of the disease is in an evolving stage. As we acquire more knowledge about COVID-19, new recommendations and guidelines are being formulated and regularly updated. This article discusses the anesthetic management of urgent neurosurgical and neurointerventional procedures. In addition, a brief overview of intrahospital transport of neurologically injured patients has been addressed.

Keywords: Corona Virus Disease 2019 (COVID-19), neuroanesthesia, neuroradiologic intervention, neurosurgical emergency

The novel coronavirus disease 2019 (COVID-19) has emerged as a pandemic affecting almost every corner of the world. It is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and commonly presents

with respiratory and general symptoms.^[1] It has also been known to present with neurological manifestations and emergencies [Table 1].^[2,3] The novel SARS-CoV-2 has been directly associated with acute hemorrhagic necrotizing

encephalopathy or may cause central nervous system infection together with systemic inflammations.^[3,4] A good number of COVID-19 infected, asymptomatic, and noninfected patients may come to hospitals with neurological manifestations apart from other non-COVID neurological emergencies, requiring urgent interventions. Anesthesiologists should be prepared to handle these cases in an efficient and timely manner while protecting themselves from the associated infection. The indicated neurosurgical procedures should be prioritized during this period [Table 2].^[5] The objectives of anesthetic management for emergencies during the pandemic should include (1) preferring of a technique that would provide best neurologic outcome, (2) minimizing the risk of cross infection for health care workers (HCWs), and (3) judiciously, using personal protective equipment (PPE).^[6]

If there is no immediate risk to life, all patients with clinical symptoms and epidemiological history should be tested for SARS-CoV-2 infection. The tests include real-time quantitative reverse transcription polymerase chain reaction (RT-qPCR) using respiratory specimens and COVID-19-specific IgM and IgG antibody tests.^[7,8] Risk of SARS-CoV-2 infection may vary with the type of procedure. Bag mask ventilation, intubation, tracheostomy, extubation, bronchoscopy, nebulization, noninvasive ventilation, chest physiotherapy, coughing/vomiting, endoscopy, use of Cavitron ultrasonic surgical aspirator, high-speed bone drilling, and craniotomy are some examples of aerosol-generating procedures (AGPs) in neurosurgical patients' population. There is a high risk of infection spread during AGPs such as tracheal intubation and extubation, tracheostomy, transnasal procedures, etc., The measures to prevent the spread of infection include the use of appropriate PPEs. Neurosurgeries are of longer duration; hence, individual preparation is important, before donning of PPEs.

Neurosurgical emergencies under general anesthesia

Induction of anesthesia and tracheal intubation should

ideally be performed in a negative-pressure environment and preferably, by the most experienced anesthesiologist in order to maximize the chance of success at first attempt.^[9] Rapid sequence induction (RSI) while minimizing bag-mask ventilation, use of video-laryngoscope, and use of special transparent intubation boxes or plastic-sheets placed over patients help in reducing exposure to aerosols during tracheal intubation. Rocuronium may be preferred over succinylcholine for RSI, especially in patients with preexisting neurologic deficits. Similar precautions should be taken during the extubation. Coughing and bucking over the endotracheal tube (ETT) should be avoided; strategies such as low-dose intravenous lignocaine or dexmedetomidine infusion may be helpful. The patients should be encouraged to wear surgical masks after tracheal extubation.^[10] It is advisable to prevent high-flow oxygenation (maintain oxygen flow of less than 6 L/min) to prevent aerosolization.^[10] Doffing of the PPE should be done, meticulously, in a designated area which should be present next to the operating room (OR). It helps preventing contamination and infection of the HCWs during the process.

Interventional neuroradiologic procedures

During the pandemic, most of the neurointerventional procedures are considered urgent and not emergent. Thus, all suspected patients should preferably undergo a test for COVID-19 prior to the procedure; appropriate PPE should be used based on the results.^[6] If the condition requires an urgent intervention, e.g., acute ischemic stroke (AIS) or worsened neurologic condition, the patient may be managed like a confirmed case of COVID-19 using appropriate PPE.^[6] Donning and doffing areas for PPEs should be established near the interventional neuroradiology (INR) suite. Other unique considerations include wearing the lead apron before donning PPE. These lead aprons should be thoroughly disinfected using wipes containing a quaternary ammonium compound and alcohol after the procedure is over.^[11]

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Access this article online	
Quick Response Code:	Website: www.joacp.org
	DOI: 10.4103/joacp.JOACP_243_20

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How to cite this article: Singh GP, Hrish AP, Rath GP. Emergency neurological procedures during COVID-19 pandemic: Practical issues. *J Anaesthesiol Clin Pharmacol* 2020;36:S104-9.

Submitted: 11-May-2020 **Revised:** 20-May-2020 **Accepted:** 07-Jun-2020
Published: 24-Jul-2020

Acute ischemic stroke (AIS)

AIS has been reported in COVID-19 patients; they may require endovascular therapy (EVT) or decompressive craniectomy (DC).^[4] These patients carry a potential risk for cross infection to HCWs when rapidly transported in-between hospital locations such as emergency department, imaging rooms, INR suites, and intensive care units (ICUs) within a short period of time. Hence, there is little or no opportunity to test for COVID-19 and may be considered as COVID-19 suspects.^[6] Requisite test to rule out COVID-19 should be done as soon as possible, however, without waiting for the results, as that would unnecessarily delay the therapeutic interventions. Rapid and focused assessment of neurological status, hemodynamics, and the airway should be performed. Patients with COVID-19 may have associated myocardial injury, thereby, exposing them to a greater risk of hemodynamic instability.^[12]

In AIS, there has to be a low-threshold, to involve anesthesiologists in the early stage of management, and to convert the technique from monitored anesthesia care (MAC) to general anesthesia (GA). Possibility of an emergent tracheal intubation and involvement of an anesthesiologist at a later stage of the procedure may lead to high-risk exposures. The anesthetic technique for EVT would vary depending on neurologic status of the patient as well as the risk of cross infection [Table 3]. Airborne precautions and PPE which include N95 masks, goggles, face shields, protective clothing, and double gloves are to be used during emergency

Table 1: Clinical Presentation of COVID-19 (Percentage Incidence)^[9]

Respiratory and General Symptoms	Neurological Manifestations (36%)
Fever (89%)	Dizziness
Cough (58%)	Headache
Dyspnea (46%)	Hypogeusia
Diarrhea (50%)	Hyposmia
Myalgias (29%)	Encephalopathy
	Altered mental status
	Impaired consciousness
Neurological Emergencies	
Acute ischemic stroke (5%-5.7%)	
Cerebral hemorrhage (1%)	

intervention/surgery (DC).^[13] Irrespective of the anesthetic technique, oxygenation, ventilation, and hemodynamic parameters should be optimized and maintained in the recommended range. Oxygen therapy should be titrated to maintain the saturation of arterial oxygenation (SpO₂) more than 94% along with normocapnia. The systolic blood pressure should be maintained between 140 and 180 mmHg.^[6,14,15] During MAC, all patients should wear a surgical mask and it should be placed on top of the nasal prongs or under a facemask.^[16] Oxygen flow rates should be kept less than 6 L/min to minimize aerosolization, and consider conversion to GA if the patient continues to be hypoxic.^[16] At the end of the procedure, extubation should not be delayed unless there are signs of respiratory or neurologic deterioration.

Angioplasty for cerebral vasospasm

Cerebral angioplasty is being increasingly used for vasospasm secondary to subarachnoid hemorrhage. It is an effective modality of treatment for symptomatic vasospasm refractory to conventional therapy.^[17] When used early (<24 h), it leads to significant clinical improvement and, thus, cannot be delayed.^[17] During pandemics, shifting the patient to INR suite and providing periprocedural care may present with additional challenges to the anesthesiologists. For clinically deteriorating patients, it is better to assess the need for tracheal intubation before shifting to INR, and if warranted, intubation is best done in ICU under controlled settings.

Neurosurgery with transnasal route

Approach to the intracranial cavity by transnasal route leads to the handling of nasal mucosa which may result in high degree of viral shedding and, hence, are considered as AGPs.^[18] Emergency transnasal pituitary surgery may be required in situations like acute loss of vision, severe pituitary apoplexy, or deteriorating sensorium.^[19,20] If the patient cannot be tested for SARS-CoV-2 for time constraints, the OR personnel should wear appropriate PPE as these patients could be asymptomatic carriers. Preoperative nasal decolonization has been suggested.^[19] Use of alternative transcranial approach may also be considered on case-to-case basis.^[19]

Table 2: Prioritization of Neurosurgical Patients during COVID-19 Pandemic^[5]

Priority Level	Description	Examples (not all inclusive)	Action
Emergency Neurosurgery	Immediate neurosurgery within 24 h	Neurotrauma, intracranial tumors with feature of decompensation or intratumoral bleed, intracranial hemorrhage, ruptured intracranial aneurysm, ruptured myelomeningocele, pituitary apoplexy with acute loss of vision, cauda equina syndrome	Immediate neurosurgery
Semiemergency/ Urgent Neurosurgery	Requires treatment within 1 week	Large tumors, e.g., Meningiomas and gliomas, unruptured aneurysm, arteriovenous malformations, spinal tumors with progressing deficits	Prioritize the case; decide on case-to-case basis
Elective Neurosurgery	Neurosurgery within 1 month	Pituitary adenoma, craniopharyngioma, degenerative spinal pathology (lumbar stenosis), schwannoma	Postpone neurosurgery and reschedule based on appropriate time

Feasibility of awake craniotomy

Generally, awake craniotomy is not indicated in emergency scenario as it is a complex procedure requiring multidisciplinary approach. During COVID pandemic, the urgency of awake craniotomy should be considered only if the benefits clearly outweigh the risks. Apart from the usual surgical indications, associated comorbidities of patient may influence decision making. Besides the usual concerns and considerations of craniotomy in an awake state, several steps are required to prepare adequately for this procedure.^[9,20] The patients should be screened for SARS-CoV-2, and/or if tested positive and remain symptomatic, image-guided resection under GA may be preferred instead of awake craniotomy.^[9,21] Specific considerations during awake craniotomy include: Regional scalp blocks or local anesthetic infiltration to provide adequate analgesia and minimize sedation requirements, prevention of cough with the use of intravenous low-dose lidocaine or remifentanyl,^[22,23] and provision of light sedation (i.e., drowsy but arousable) before neurocognitive assessments.^[1] The patient should wear a surgical mask during the procedure and supplemental oxygen may be given by facemask placed over it.

Thromboembolism and anticoagulation in COVID-19 patients

SARS CoV-2 viral infection in severe cases result in cytokine storm, systemic inflammatory response, and coagulopathy with poor prognosis. Coagulopathy induced by COVID-19 is more commonly prothrombotic than hemorrhagic with increases in fibrin, fibrin degradation products, fibrinogen, and D-dimers and these markers are associated with worse clinical outcome.^[24-26] Pharmacologic prophylaxis of venous thromboembolism (VTE) is recommended for all hospitalized patients with confirmed or highly suspected COVID-19 patients regardless of VTE risk assessment scores.^[27-29] If the pharmacologic prophylaxis is contraindicated due to presence of active bleeding, profound thrombocytopenia, or immediate post-craniotomy procedures, mechanical prophylaxis with intermittent pneumatic compression devices should be utilized. For critically ill ICU

patients with confirmed or highly suspected COVID-19, increased doses of thromboprophylaxis are recommended such as enoxaparin 0.5 mg/kg or 40 mg subcutaneous twice daily, heparin 7500 units subcutaneous three times daily, or low-intensity heparin infusion.^[30] For all other noncritically ill hospitalized patients with highly suspected or confirmed COVID-19, standard dose of prophylaxis as for any other hospitalized surgical patients should be followed.^[30] Use of low molecular weight heparin (LMWH) is recommended over unfractionated heparin (UFH) whenever possible in patients with COVID-19. This approach avoids additional laboratory monitoring, minimizes nursing and phlebotomy exposure, and limits the use of PPE. However, use of UFH is recommended over LMWH in patients with acute kidney injury or creatinine clearance less than 15–30 mL/min.^[30] The usual concerns of anticoagulation therapy prior to and following the neurosurgical procedures stands valid in COVID-19 positive patients as well and the routine protocols for anticoagulation should be followed like in any non-COVID-19 patient undergoing neurosurgical intervention.

Cerebrospinal fluid infectivity and precautionary measures

There have been reports of COVID-19 meningitis/encephalitis which shows the neuroinvasive potential of the virus. In that specific case, though the RT-PCR test for SARS-CoV-2 was found to be negative with nasopharyngeal specimen, it was detected in the cerebrospinal fluid (CSF) sample.^[31] Thus, HCWs should take all necessary precautions while handling CSF of COVID-19 positive or suspects, especially when the CSF diversion procedures or invasive intracranial pressure (ICP) monitoring techniques are being carried out.

Intrahospital transport of neurologically injured COVID-19 patients

When a COVID-19 patient is transported, the HCWs in the

Table 3: Suitability Criteria for MAC vs. GA for Endovascular Therapy (EVT) during COVID-19 Pandemic^[2]

Scenario in which MAC may be Preferred	Scenario in which GA may be preferred
Suspected COVID-19 patients with: No signs of acute respiratory distress or hypoxemia and require high flow oxygen No signs of active cough or vomiting Able to protect airway	Suspected/Confirmed COVID-19 patients with signs of: Acute respiratory distress/hypoxemia and require high flow oxygen Active cough Active vomiting Inability to protect airway
Occlusions in: Anterior circulation Nondominant cerebral hemisphere NIHSS score <15 GCS score >9	Occlusions in: Posterior circulation Dominant cerebral hemisphere NIHSS >15 (Severe stroke) GCS score <9
Calm/cooperative patients	Agitated/uncooperative/aphasic patients

MAC; Monitored Anesthesia Care; GA: General Anesthesia; NIHSS: National Institute of Health Stroke Scale; GCS: Glasgow Coma Scale Score

receiving area should be notified in advance.^[24] A preplanned dedicated transport route to each destination is encouraged and transport assistants need to ensure clearance of this entire route ahead of patient transportation. The HCWs should not touch environmental surfaces such as elevator buttons; a security personnel or transport assistant should manage it.^[32] Transportation to less-necessary places (e.g., Imaging room) should be avoided; alternative options in the form of bedside gadgets (e.g., ultrasound/portable X-ray/portable computed tomographic scan) should be utilized.^[32] The patients should wear facemask during transportation and the transport personnel should wear all recommended PPE. In intubated patients, HEPA filters should be added to ETT before an AMBU is connected.^[32] Care must be taken to avoid unnecessary disconnection; in case disconnection is required, the ETT should be clamped beforehand. Adequate care should be taken while applying and removing the clamp.

Conclusions

The spread of COVID-19 pandemic has led to the emergence of new challenges for healthcare workers throughout the globe. New guidelines and recommendations are being formulated and are regularly evolving as we continue to acquire more and more knowledge about the disease. During this difficult time, the anesthesiologists continue to manage the neurologically injured patients in OR, ICUs, and INR suites. Hence, they should be aware of specific considerations related to anesthesia for the urgent neurosurgical and neurointerventional procedures, and also, the measures to protect themselves from COVID-19.

Acknowledgements

The authors acknowledge constant encouragement of Dr. Anju Grewal for preparing this manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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