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Neuroanesthesia Practice during the COVID-19 Pandemic: Recommendations from Society for Neuroscience in Anesthesiology & Critical Care (SNACC)

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Abstract

The pandemic of coronavirus disease 2019 (COVID-19) has several implications relevant to neuroanesthesiologists, including neurologic manifestations of the disease, impact of anesthesia provision for specific neurosurgical procedures and electroconvulsive therapy, and healthcare provider wellness. The Society for Neuroscience in Anesthesiology and Critical Care appointed a task force to provide timely, consensus-based expert guidance for neuroanesthesiologists during the COVID-19 pandemic. The aim of this document is to provide a focused overview of COVID-19 disease relevant to neuroanesthesia practice. This consensus statement provides information on the neurological manifestations of COVID-19, advice for neuroanesthesia clinical practice during emergent neurosurgery, interventional radiology (excluding endovascular treatment of acute ischemic stroke), transnasal neurosurgery, awake craniotomy and electroconvulsive therapy, as well as information about healthcare provider wellness. Institutions and healthcare providers are encouraged to adapt these recommendations to best suit local needs, considering existing practice standards and resource availability to ensure safety of patients and providers.

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Introduction

The novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), first emerged in Wuhan, China, in December 2019,[1] and has since spread across the globe. On 11 February 2020, the World Health Organization named the disease caused by this virus COVID-19, and subsequently declared a pandemic on 11 March 2020.[2] COVID-19 is characterized by fever (89%), cough (58%), dyspnea (46%), myalgias (29%), lymphopenia[3] and typical chest imaging features of bilateral ground glass opacities and consolidation.[4] Although symptoms can range from mild to severe, 20% of infected patients overall require admission to an intensive care unit.[3] Risk factors for severe disease or death include older age, smoking, chronic obstructive pulmonary disease, diabetes, hypertension, immunocompromise and malignancy.[5, 6] COVID-19 has several implications relevant to neuroanesthesiologists, including neurologic manifestations of the disease, impact of anesthesia provision for specific neurosurgical procedures and electroconvulsive therapy (ECT), and healthcare provider wellness.

Aim and scope

The aim of this document is to provide a focused overview of the novel SARS-CoV-2 virus and COVID-19 disease relevant to neuroanesthesiologists. This statement provides information on the neurological manifestations of COVID-19, advice for neuroanesthesia clinical practice during emergent neurosurgery, interventional radiology (excluding endovascular treatment of acute ischemic stroke), transnasal neurosurgery, awake craniotomy and ECT, as well as information about healthcare provider wellness. Guidelines for the anesthetic management of endovascular therapy for acute ischemic stroke during the COVID-19 pandemic are available in separate guidance from the Society for Neuroscience in Anesthesiology and Critical Care (SNACC).[7] The information provided in this document can be used to inform local and institutional policies and procedures. Information about COVID-19 will evolve as our knowledge about this virus increases over the coming months. The recommendations provided herein reflect expert consensus opinion based on the information available at the time of writing (April 2020) and are subject to change as knowledge increases. Finally, the recommendations can be adapted to regional and institutional resources and requirements, considering existing practice standards and resource availability, to ensure the safety of patients and providers.

Writing Group

The authors of these consensus guidelines were appointed by SNACC, and chosen based on their clinical expertise in various aspects of neuroanesthesia practice and to represent a range of geographic locations (North America, Australia, Europe, China and India) and clinical practice settings. The guidelines were made available to SNACC members for review and were approved by the Board of Directors of SNACC prior to publication.

Neurological manifestations of COVID-19

The neurological manifestations of COVID-19 have only recently been described. Preliminary unpublished evidence suggests that COVID-19 positive patients are at increased risk of acute ischemic stroke. A recent report from China suggests that neurological symptoms, such as dizziness, headache, hypogeusia and hyposma, are common (36%) in patients with COVID-19.[8] Encephalopathy and altered mental status have also been reported in patients infected with the SARS-CoV-2 virus.[9] Cerebrovascular disease is more common in severe COVID-19 disease; acute ischemic stroke has been reported in 5.7% and impaired consciousness in 15% of patients with severe disease.[8] These results are consistent with another report of 221 patients from Wuhan, China, which found a 5% incidence of acute ischemic stroke and a 1% incidence of cerebral hemorrhage.[10] In this cohort, patients with cerebrovascular complications were more likely to be older, have severe COVID-19 disease, and demonstrate evidence of hypercoagulability and inflammation. Ultimately, 38% of patients with cerebrovascular complications died. Together, these preliminary reports suggest that patients with COVID-19 could present more frequently for endovascular treatment of acute ischemic stroke and could also be at elevated risk of perioperative stroke if they require surgery during acute infection.

Other coronaviruses with close similarity to SARS-CoV-2 have been shown to invade the central nervous system. The SARS-CoV and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) viruses are closely related to the SARS-CoV-2 virus in structure and infection pathway, and both have been shown to infect the CNS in animal models; the brainstem was found to be heavily infected by both SARS-CoV[11] and MERS-CoV.[12] Furthermore, CNS infection was closely related to high mortality rate, possibly due to dysfunction of the cardiorespiratory center in the brainstem. A predisposition to neuroinvasion is considered to be a common feature of the coronavirus family, and the SARS-CoV-2 virus should be presumed to have similar features.[13] The alterations in smell observed with COVID-19, in particular, have been postulated to reflect the access of the virus to the brain through the transcribrial route as described in other pathogens;[14] although this remains to be proven for SARS-CoV-2. Overall, direct invasion of the CNS is plausible, and may account for some of the neurological symptoms reported by COVID-19 positive patients.[13]

Urgent neurosurgical procedures

The COVID-19 pandemic has necessitated a reduction in elective surgeries to increase capacity and free up resources;[15-17] this includes limitations on neurosurgical procedures. Nevertheless, some patients will continue to require emergent and urgent neurosurgical intervention for life-threatening conditions. The hard-hit region of Lombardy, Italy, described creating a centralized network of three “hub” hospitals that accepted all urgent neurosurgical referrals, while one additional center was designated for urgent oncological neurosurgery.[18] Urgent neurosurgery will require specific considerations during the pandemic (Figure 1).

The diagnostic criteria for suspected or confirmed COVID-19 cases include epidemiological history, clinical manifestation, real-time quantitative fluorescence polymerase chain reaction (RT-qPCR) test and COVID-19-specific IgM and IgG antibody test. RT-qPCR testing of respiratory specimens,[19] including nasopharyngeal swabs, bronchoalveolar lavage fluid, sputum, or bronchial aspirates, for SARS–CoV-2 RNA is currently widely used for case diagnosis.[1, 20] Due to the possibility of false-negative RT-qPCR test results,[21] RT-qPCR testing on two consecutive respiratory samples obtained at least 24 hours apart should be considered when resources allow.[22] Together, typical clinical symptoms, chest imaging, and epidemiological history (travel or high risk exposure) can be used to assess the risk of COVID-19 infection and indication for testing. The accepted criteria for the diagnosis of COVID-19 include one of the following: 1) RT-qPCR positive for COVID-19 nucleic acid; 2) the viral gene identified by gene sequencing is highly homologous with known COVID-19; or, 3) presence of COVID-19-specified IgM and IgG antibodies.

For patients requiring aerosol-generating procedures by providers, protection against viral aerosolization should be used for all patients using an N95 mask or powered, air-purifying respirator.[23] Anesthesiologists should refer to detailed published recommendations for the perioperative management of COVID-19 patients,[24-27] which are summarized as follows:

1. To conserve PPE and limit exposure, only essential personnel should be present for aerosol-generating procedures that occur during general anesthesia. Ideally, induction of anesthesia and intubation should be performed by an experienced provider in a negative-pressure

environment, and intubation performed using rapid sequence induction with videolaryngoscopy while minimizing bag-mask ventilation. Extubation following general anesthesia should, if possible, also be performed in a negative-pressure environment using airborne PPE. Coughing should be avoided during extubation. The patient should wear a surgical mask after extubation and high flow oxygen (i.e. <6 L/min) avoided given the risk of aerosolization.[28] Finally, patient transportation also requires attention to safety and minimization of contamination. Extubated patients should receive oxygen via face mask and, if possible, an additional surgical mask placed on the patient underneath.[24]

Transnasal neurosurgical procedures

Transnasal endoscopic neurosurgery facilitates access to the sellar region and is most frequently employed for transsphenoidal hypophysectomy for pituitary tumors. The SARS-CoV-2 virus is believed to have a high degree of viral shedding from the nasal mucosa,[29] and early reports from Wuhan, China, have highlighted the propensity of nasal surgery, such as transsphenoidal hypophysectomy, to aerosolize virus with high potential for transmission.[30] Early in the pandemic in China, before testing became widespread, emergency transsphenoidal hypophesectomy resulted in viral transmission to multiple healthcare workers within days of the surgery, even with appropriate PPE.[30] As a result of widespread reports of infected colleagues, concern has rapidly escalated amongst otolaryngologists about the safety of nasal surgery.[30] Despite these concerns, patients may still require urgent or emergent transsphenoidal hypohysectomy, such as for acute vision loss, severe pituitary apoplexy or deteriorating level of consciousness.[31] Recent guidance has highlighted the high risk of nasal surgery in patients infected with SARS-CoV-2, making recommendations to defer non-urgent surgery, to evaluate for SARS-CoV-2 via symptoms, radiological imaging and two COVID RT-PCR tests separated by 24 hours, and about the use of appropriate PPE.[32, 33] Preoperative nasal decolonization could also be considered.[34] If transsphenoidal hypophysectomy is required urgently, and rapid SARS-CoV-2 testing is not available, then identifying infected patients becomes problematic due to the high proportion of asymptomatic patients. As such, the minimum number of essential staff should be in the operating room and use appropriate PPE (Figure 1). An alternative surgical approach may also be considered when rapid SARS-CoV-2 testing is not available or the patient is confirmed to have COVID-19, i.e. craniotomy rather than the transnasal approach.[30, 35] These options should be considered on a case-by-case basis.

Awake Craniotomy

An awake craniotomy requires the patient to be fully conscious in order to participate in neurocognitive testing during surgery, although the patient can be awake, sedated, or under general anesthesia before and after periods of intraoperative testing.[36] Awake craniotomy is typically used for brain tumor and epilepsy surgery when the lesion is in close proximity to eloquent areas of the brain, in order to facilitate surgeon's decision-making.[37] During the COVID-19 pandemic, an awake craniotomy presents several challenges for neuroanesthesiologists, with little specific evidence available to guide practice. The following discussion primarily reflects the expert opinion of taskforce members.

The role of awake craniotomy will be modified during the COVID-19 pandemic (Figure 1). First, in principle, an awake craniotomy should not be performed emergently given its' relative complexity, although occasionally an urgent awake (versus asleep) craniotomy may be indicated for surgical reasons and patient comorbidities.[38] Secondly, awake craniotomy can offer unique benefits to patients,[39] and should still be considered for selected patients during the pandemic. The relative risks and benefits must be carefully considered, as well as alternatives such as image-guided resection if available. Several steps are required to adequately prepare for awake craniotomy during the pandemic. Before the procedure, patients should be carefully screened for the presence of the SARS-CoV-2 virus through clinical assessment and RT-qPCR testing. If the patient presents with respiratory symptoms or hypoxemia preoperatively, the etiology should be investigated, and the patient tested for COVID-19. If the patient is positive for COVID-19, or remains symptomatic, an awake craniotomy is not recommended.

Different awake craniotomy anesthetic techniques have been described: awake throughout without any sedation, conscious sedation or monitored anesthesia care, asleep-awake technique, and asleep-awake-asleep technique.[40] The specific technique chosen should be familiar, while also minimizing the risk for urgent airway intervention. Whatever technique is chosen, during the COVID-19 pandemic coughing during awake craniotomy should be avoided to minimize the potential for contamination and aerosolization. This can be mitigated through the use of intravenous medications such as low dose lidocaine or remifentanil.[41, 42] In addition, we advocate an approach that avoids airway instrumentation and uses only light sedation (i.e. drowsy but arousable) before neurocognitive testing. Urgent airway intervention, including nasal airway insertion, is particularly detrimental during this pandemic. In addition, regional scalp blocks and/or local anesthetic infiltration are essential to provide analgesia and minimize sedation requirements. Given that individuals can potentially be infected by SARS-CoV-19 and remain asymptomatic,[43] patients should wear a surgical mask whenever possible, including during the procedure; the mask can be temporarily removed during neurocognitive testing. Supplemental oxygen (i.e. face mask) can be placed over the surgical mask if needed. A microphone may facilitate intraoperative communication while using PPE, and maintain distance between the patient and the operating room team to lessen the chance of cross infection.

Neurointerventional radiology procedures

With the exception of endovascular therapy for acute ischemic stroke, most neurointerventional radiology procedures performed during the pandemic will be considered urgent, rather than emergent (e.g. embolization of intracranial aneurysms, spine tumors). Therefore, any patients with suspected COVID-19 should be tested prior to undertaking the procedure (provided the results of testing is available in <24 hours), and appropriate PPE implemented according to institutional policies. For cases where testing is not possible due to case urgency, the patient should be treated as presumed COVID-19 positive. Only essential personnel should be present during airway management and, ideally, intubation should be performed in an airborne isolation room with negative pressure relative to the surrounding area.[44] However, it is recognized that this may not be available near many interventional radiology suites, and that intubation will then need to occur in the radiology suite with only essential personnel present.

Anesthesia for neurointerventional radiology procedures during the pandemic requires several other, unique, considerations (Figure 1). For example, anesthesia providers must ensure that lead protection is donned before PPE, as the anesthesia practitioner may be required to remain in the interventional radiology suite rather than the control room. Afterwards, the lead suits worn during the procedure require rigorous decontamination with disinfection wipes containing a quaternary ammonium compound and alcohol;[34] a top-down cleaning sequence may reduce bioburden. Locations for donning, doffing and cleaning of lead will need to be established in close proximity to the interventional suite, and appropriate PPE made available in that location. Finally, given the remote location of many interventional radiology suites, a plan for extubation is required. Transport to a negative pressure isolation room in another location for extubation should be considered. After extubation, as a minimum, caution must be taken to ensure that patients are transported without risk of urgent airway intervention or coughing during transit.

Electroconvulsive therapy

Electroconvulsive therapy is an effective treatment for a wide variety of neurological and psychiatric disorders.[45, 46] During and following the COVID-19 pandemic, we should prepare for a potential increase in demand for ECT procedures. Pandemics are likely to cause damaging effects on mental health. These include increases in suicide rates, particularly in survivors of the disease, health care providers, and previously healthy but isolated or quarantined populations. Of particular concern are those affected by the economic down fall; the suicide rate in the US rose dramatically during the Great Depression.[47] A previous outbreak of a related virus, SARS-CoV-1, in 2003 significantly impacted the mental health of SARS survivors and health care providers; 41% - 65% of SARS survivors suffered persistent psychologic and/or psychiatric problems, predominantly post-traumatic stress disorder and depression. These symptoms often last as long as 30 months after recovery from SARS, including in healthcare providers who were infected and recovered.[48, 49] Even healthy healthcare providers who were not infected experienced substantial psychological distress years after the outbreak.[50] At the time of writing (April 2020), the magnitude of the COVID-19 pandemic is at least two orders greater than that of SARS and a recent survey suggests that health care providers taking care of COVID-19 patients in China report high rates of distress, depression, anxiety, and insomnia.[51]

During the COVID-19 pandemic, the risks and benefits of ECT must be carefully assessed. ECT should be considered as an urgent or semi-urgent intervention for suicidal ideation, severe depression, mania and catatonia and should not be delayed.[45, 52] However, when considering

ECT, both the anesthesiologist and psychiatrist must ensure that all conservative interventions have been pursued and exhausted prior to administration of ECT as a "last resort" therapy.[45]

The patient population commonly undergoing ECT presents specific challenges during the COVID-19 pandemic. As ECT patients tend to be older[53] and with comorbidities, they are at higher risk for both ECT-associated[54] and COVID-19-related morbidity and mortality.[5, 6] Only those asymptomatic for COVID-19 disease should be considered for ECT, and each patient should be tested for SARS-CoV-2 virus close to the time of their procedure. SARS-CoV-2 positive patients should not be allowed to proceed with ECT. If asymptomatic, patients who test positive for SARS-CoV-2 but remain asymptomatic should be allowed to proceed only if subsequent testing 14 days later is negative, and ECT is considered a life-saving procedure.

The conduct of anesthesia for ECT during the COVID-19 pandemic requires careful consideration (Figure 2). The most challenging aspect of anesthesia for ECT during the pandemic is airway management. The commonly used technique of bag-mask ventilation and hyperventilation without an airway device represents significant risk of infection for healthcare providers, including anesthesiologists.[55] To minimize risk of viral transmission, the following are recommended:

1. Since anesthesia management for ECT inevitably involves positive pressure bag-mask ventilation with an unprotected airway, it should ideally be performed in a negative pressure single airborne suite, utilizing full PPE, restricted personnel, and careful disinfection (e.g. minimum 75% alcohol[52]) of the suite, allowing at least 30 minutes between patients[55, 56] depending on institutional air exchange rate;

2. To minimize hypersalivation, glycopyrrolate 0.2-0.4 mg intravenously can be safely administered prior to induction of anesthesia[57];

3. To reduce coughing on emergence, remifentanil can be safely administered during the procedure and lidocaine (1-1.5 mg/kg of ideal body weight) can be administered intravenously after the seizure is completed;[55, 56]

4. Although hyperventilation using bag-mask ventilation can improve seizure quality, the evidence for this is weak[58] and aerosolization is increased. Therefore, this strategy should be avoided during the COVID-19 pandemic unless adjustment to other measures to improve seizure quality is unsuccessful. Induction agents providing best possible quality of seizure should be employed; these include ketamine, etomidate and methohexital.[59]

5. Patients should be carefully preoxygenated prior to induction of anesthesia when bag-mask ventilation is minimized; consider apneic oxygenation with nasal prongs[55];

6. In cases requiring hyperventilation, a laryngeal mask airway allowing capnography[55] should be considered as an alternative to manual bag-mask ventilation;

7. Patients should be recovered in designated areas wearing surgical masks[52, 55]

Wellness for health care providers

During a pandemic, the concept of "duty to treat" by healthcare workers is a given, although many significant changes are observed in healthcare delivery and risks to healthcare providers.[60] The notion of self-sacrifice is a grave mistake; success in controlling and ultimately eradicating a pandemic depends on availability of all resources, including personnel.[61] Physicians, nurses and other health care workers may not realize that during a pandemic the nature of "the patient" changes from a single individual to a community. Thus, we reinforce the utmost importance of safety to preserve the human resources necessary to overcome the pandemic. The wellness of healthcare workers should encompass both physical and mental fitness (Table 1).

Physical wellness is a primary concern to maintain a sustainable workforce during a pandemic. In addition to the risks that general anesthesiologists face in becoming infected with the virus, including during airway management, neuroanesthesiologists have additional exposure risk due to their close proximity to patients and long surgical procedures. Wearing PPE for a prolonged time may cause excessive heat, pressure sores and a need for frequent rehydration; neurointerventional procedures may be particularly uncomfortable due to the addition of lead protection under the PPE. It is essential that all steps of doffing should be thoroughly completed and meticulous hand washing performed before any consumption, and that all food or drink is consumed outside of any patient care area. Due to these practice restrictions, neuroanesthesiology departments should ensure additional staffing is available to provide breaks and clinical support during cases.

Psychological health is of critical importance. Anesthesiologists and intensivists are at the front line of the management of the target organs that the COVID-19 virus attacks and are faced with the task of rapidly reviewing and implementing continually evolving guidelines. In addition to the general anxieties felt during the pandemic, healthcare practitioners face substantial stress due to the challenges of remembering guideline recommendations and implementing them with minimal time to practice. A change (increase) in the number of work hours and assignments outside familiar environments and skill sets may be difficult for some. Physicians and other health care workers may also have concerns about transmitting the virus to their home environment.[62]

High levels of anxiety can arise during deviation from routine workflow and this anxiety, along with long hours of work, can negatively affect the immune system of health care workers. Healthy nourishment, adequate sleep, and scheduled breaks are ways to cope with stress in pandemic situations. Many hospitals have support systems for all front-line healthcare professionals managing patients during a high mortality pandemic. There should be counseling and designated areas for rest in accordance with social distancing rules.[63] The American Medical Association has released resources for health care leadership to guide them in supporting providers during the COVID-19 pandemic, including sustaining physical and mental well-being.[64] Ultimately, a pandemic is a battle; the well-being of the health care professionals who fight the battle is essential in ensuring victory.

Conclusions

Since the novel SARS-CoV-2 virus first emerged in late 2019 in China, the COVID-19 pandemic has spread around the globe and caused massive disruptions to healthcare provision. Neuroanesthesiologists should be aware of several specific considerations related to anesthesia for urgent neurosurgical and neurointerventional procedures, as well as ECT. These recommendations will continue to evolve as the pandemic progresses, particularly as we gain further insights into the pathophysiology, clinical course, and treatment options for COVID-19.

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LEGENDS TO FIGURES

FIGURE 1

Summary of recommendations for the anesthetic management of urgent neurosurgical procedures during the COVID-19 pandemic.

PAPR, powered, air-purifying respirator; PPE, personal protective equipment; RT-qPCR, real-time quantitative fluorescence polymerase chain reaction

FIGURE 2

Summary of recommendations for the anesthetic management of electroconvulsive therapy during the COVID-19 pandemic.

ECT, electroconvulsive therapy; SARS-COV-2, severe acute respiratory syndrome coronavirus 2

Table 1

Wellness for health care providers

- During a pandemic, the physical and mental health of healthcare professionals is essential for sustainability
- Prolonged procedures, physical exhaustion, a high risk of contamination and psychological stress are common in neuroanesthesia practice
- Neuroanesthesiology departments should ensure additional staffing is available to provide breaks and clinical support during long cases, particularly when PPE is required
- Multiple specialty Societies provide resources on strategies to relieve stress and improve wellness

URGENT NEUROSURGICAL PERIOPERATIVE CONSIDERATIONS
DURING COVID-19 PANDEMIC

PREPARATIONS FOR URGENT NEUROSURGERY

SCREEN

Test for COVID-19 using a combination of:

- ❑ CLINICAL HISTORY
- ❑ CHEST IMAGING
- ❑ RT-qPCR testing

PROTECT

Donn appropriate PPE

- ❑ N95 MASKS
- ❑ PAPRs

PRECAUTION

Donn appropriate PPE

- ❑ SURGICAL MASKS ON PATIENTS AFTER EXTUBATION

TRANSSPHENOIDAL SURGERY

- **HIGH, CONTINUOUS** degree of viral shedding nasopharyngeal mucosa manipulation
- Screen or postpone if possible
- Consider **ALTERNATIVE** approaches such as open craniotomy
- All staff must be in appropriate, AGP protective PPE for entire procedure

NEURO-INTERVENTIONAL PROCEDURES

- Utilize rapid <24 hr COVID-19 rule out testing if possible.
- **AEROSOL-GENERATING PROCEDURES** (intubation, extubation) in dedicated airborne isolation rooms
- Wear **LEAD** under PPE gowns

AWAKE CRANIOTOMY

- **CAN BE OFFERED** in select patients
- Limit airway interventions and minimize coughing
- Patients must wear surgical mask
- **PREPARE** for emergent airway management with access to PPE
- Patients should wear surgical mask with <6L/min supplemental O_2 flow

SNACC

ELECTROCONVULSIVE THERAPY DURING COVID-19 PANDEMIC

Perioperative Considerations

PATIENT SELECTION

Each patient should be tested for SARS-COV-2

If SARS-COV-2 positive, **WAIT** 14 days after a subsequent negative test

SYMPOMATIC, SARS-COV-2 POSITIVE patients should **NOT** undergo ECT

AIRWAY MANAGEMENT

- **POSITIVE PRESSURE** mask ventilation is often a common practice during ECT procedures
- This practice may risk viral aerosol generation and possible spread to healthcare workers.
- Practices to minimize positive pressure mask ventilation should be considered

Use **CAREFUL PREOXYGENATION** and **APNEIC OXYGENATION**

MINIMIZING MASKING STRATEGIES

- **AVOID** hyperventilation
- Consider glycopyrrolate dose to minimize hypersalivation and prevent cough
- Consider anti-tussive strategies on emergence, i.e. IV remifentanil or lidocaine

Utilize a **NEGATIVE PRESSURE ROOM** if possible.

RECOVERY

Recover patients in designated areas with **SURGICAL MASK**

Allow **30 MINUTES** between patients and treatments