

## Letter: Considerations for Performing Emergent Neurointerventional Procedures in a COVID-19 Environment

To the Editor:

COVID-19 syndrome, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus, most commonly presents with upper respiratory infectious symptoms and may lead to hypoxemic failure, the most common cause of ventilation support.<sup>1-5</sup> There may be a hypercoagulable state during SARS-CoV-2 infections that could lead to an increased vascular thrombotic phenomenon and a potential need for neurointerventional procedures.<sup>6-8</sup> We aim to outline practices to be considered when managing COVID-19 patients requiring neurointerventional care.

### GENERAL PLANNING

Given the number of SARS-CoV-2 infections within the community, patients presenting with neurological emergencies needing immediate interventional therapy will not be able to be tested in time, and thus such patients should be considered as persons under investigation (PUIs) for SARS-CoV-2 viral infection.<sup>4</sup> Care of such patients should be performed with maximal personal protective equipment (PPE), including N95 masks.<sup>9,10</sup>

- All patients needing emergent neurointerventional procedures should be considered PUIs.
- Maximal PPE should be employed when performing emergent neurointerventional procedures on COVID-19 or PUI patients.

### Personnel

It is ideal to minimize the number of neurointerventional radiology (NIR) attendings, fellows, nurses, and technologists who are in-house at any one time to minimize personnel exposure to SARS-CoV-2.<sup>11</sup> This is feasible with a general trend towards canceling elective procedures during the pandemic. Members of the NIR team need to be appropriately fitted with the N95 mask and be aware as to how to obtain all appropriate PPE as N95s may be stored in secure environments. Those who have facial hair or cannot tolerate an N95 must be trained to use a powered air purifying respirator (PAPR) or follow alternative institutional protocols. One can reuse the N95 for up to 8 h without an outer cover; however, when a face mask is worn over the N95 to prevent gross contamination, its reuse can be extended.

During cases it is imperative that team members within the NIR suite restrict their movement and not enter clean areas until the procedure is completed and they have doffed their PPEs appropriately. This will necessitate that a member of the team

be placed in the clean control room to obtain the equipment necessary during the procedure.

- The number of NIR personnel within the hospital setting should be minimal.
- All team members must be fitted appropriately with N95 masks.
- An outer standard surgical mask should be worn over the N95 to prolong the shelf life of the N95.
- NIR personnel should be divided as such to prevent the movement of NIR suite personnel to clean areas.

### NIR Suite and Control Room

NIR suites are typically positive-pressure areas to minimize outside infectious contaminants and prevent procedure-related infections; however, this also increases the risk of spreading aerosolized respiratory secretions from COVID-19 patients. Reports from Singapore and New York University share the idea of converting COVID-designated NIR suites into negative-pressure areas with high efficiency particulate air (HEPA) filters, thus reducing the risk of contaminating air flow systems and minimizing the exposure of clean areas to infectious particulate matter. While there may be a theoretical risk of increasing surgical site infections (SSIs) in a negative-pressure environment, this may be outweighed by the benefits of minimizing the exposure of clean areas to infectious matter.<sup>12</sup>

If a facility has 2 NIR suites, one should become the designated suite for COVID+/PUI patients and the other for documented COVID-19-negative patients. The inventory in the COVID-19-designated suite should remain in closed storage closets at all times, or a barrier such as plastic sheets could be secured to cover the inventory. Infrequently used inventory should be removed from the suite and could be stored in the control room or an adjacent anteroom.

In addition, you must determine if the control room attached to the COVID NIR suite can be maintained as a clean environment. This can be done if the pressure of the control room can be changed to be higher than that of the NIR suite. If this can be achieved, then portable material within the NIR suite can be moved to the control room. If the control room cannot be maintained as a clean environment, then it is ideal to move nonessential portable equipment from the control room, as it also may require a terminal clean. All COVID-contaminated areas (NIR suite and possibly the control room) will need terminal cleaning from ceiling to floor, including the lights and air ducts.

- Designate one NIR suite as COVID NIR and remove all portable equipment that may get contaminated.
- Predetermine supplies needed for the NIR case and take those to COVID NIR.

- Keep the clean control room entrance to the COVID NIR room closed at all times during the procedure.
- Maintain 1 team member in the NIR control room to seek needed supplies.

### Anteroom

An anteroom serves as a gateway from the COVID-designated NIR suite to the halls, preventing infectious particulate matter from reaching the halls.<sup>13</sup> The anteroom is a small area outside of the NIR suite under negative pressure and fitted with a HEPA filter allowing for personnel to remove their PPE and wash hands before entering a clean area. The negative pressure within the anteroom prevents contaminated particulate matter from traveling to other parts of the hospital. Most NIR suites may not have an attached anteroom, thus engineering staff should be contacted to build a portable anteroom for the COVID NIR suite.

- Build an anteroom attached to the COVID-NIR suite to prevent contamination of adjacent clean areas.

## PREOPERATIVE, OPERATIVE, AND POSTOPERATIVE BEST PRACTICES

### Transfer from emergency department (ED) to NIR Room

All nonintubated patients being transported should have a face mask in place. For an intubated patient, it is safest to maintain a closed circuit until after the procedure is concluded. If that is not possible, extreme caution must be taken while clamping the tube when transferring from bagging to ventilator, or ideally the patient may remain on a single ventilator from ED until after treatment, when the ventilator can be changed in a negative-pressure setting.

- All personnel working with COVID-19 patients should have maximal PPE.
- A face mask should be placed on all nonintubated patients during transport.
- Endotracheal tubes should be clamped before transferring to ventilator.

### Intubation and Procedure

With most NIR emergencies (subarachnoid hemorrhage, carotid blow out, epistaxis, etc), intubation becomes essential for the protection of the airway; however, with large vessel occlusion (LVO)-related ischemic stroke, there continues to be a lack of guidance for the best practice. If intubation is to be performed, it should ideally be performed in a negative-pressure environment to minimize the contamination of adjacent areas and personnel, and hypotension should be avoided in stroke patients.<sup>14</sup> If intubation must be performed in the NIR suite, then only anesthesia staff donning appropriate PPE should be present within the room, and postintubation a barrier around the patient's face should be applied to contain aerosolization.<sup>15</sup> Before entering the NIR suite, you should wait for a period of time (determined by your

engineering team) to minimize aerosolized particulate matter within the NIR environment; however, such delays will not be ideal in cases of LVO-related stroke patients. If a negative-pressure room is available, full recirculation time is typically around 3 min, so staff may re-enter the room within 5 min.

Other centers have not changed their anesthesia/intubation paradigms secondary to the COVID status. In these circumstances, patients remain on nasal cannula O<sub>2</sub> with a face mask, and there is not a need to extubate, which is the largest producer of aerosolized matter. Thus, performing thrombectomies without intubation allows for the avoidance of intubation and extubation (highest risk of aerosolization), risk of patient continuing to be intubated and requiring ventilator and intensive care unit (ICU) room, and prolonged recovery times.

- Intubation and extubation lead to maximal aerosolization and contamination.
- Intubation and extubation should ideally be performed in negative-pressure rooms.
- NIR personnel should not be present for intubations/extubations.
- NIR should enter with appropriate PPE once airway is secure and patient face barrier is in place.

### Extubation and Transfer to Final Destination

While it is ideal if resources allow for the transport of an intubated patient into a negative-pressure room to extubate, this may be unlikely given the rise in the COVID patient population requiring critical care services and negative-pressure rooms. Thus, if possible, extubate the patient within the NIR environment under the same conditions as described for intubation. Once the patient is extubated and has stopped coughing, it is ideal to transport to the final destination rather than an intermediary stop within the postanesthesia care unit (PACU). This will minimize contamination during transport and minimize the number of healthcare personnel exposed. For those patients not intubated, extubation is avoided; however, they should also be transported to the final destination with a face mask and without stopping in a PACU environment. Flat-panel detector computed tomography (CT) scanning capabilities of modern angiographic equipment may also reduce the need to transport to postprocedure CT.

- Extubate with a minimal number of surrounding personnel (must use N95s).
- Transfer the patient to the final destination rather than an intermediary location (PACU).
- Terminal clean the COVID NIR suite.

## CONCLUSION

The COVID-19 pandemic is affecting most regions of the United States, necessitating a change in our practice patterns. We have outlined general principles to be taken into consideration as neurointerventional teams look to care for their patients while

preventing the exposure of other patients as well as healthcare personnel.

## Disclosures

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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## REFERENCES

- Bhatraju PK, Ghassemieh BJ, Nichols M, et al. Covid-19 in critically ill patients in the Seattle region—case series. *N Engl J Med*. published online: March 30, 2020 (doi:10.1056/NEJMoa2004500).
- Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. The species *severe acute respiratory syndrome-related coronavirus*: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat Microbiol*. 2020;5(4):536-544.
- Lillicrap D. Disseminated intravascular coagulation in patients with 2019-nCoV pneumonia. *J Thromb Haemost*. published online: March 24, 2020 (doi:10.1111/jth.14781).
- Spellberg B, Haddix M, Lee R, et al. Community prevalence of SARS-CoV-2 among patients with influenza-like illnesses presenting to a Los Angeles medical center in March 2020. *JAMA*. published online: March 31, 2020 (doi:10.1056/NEJMoa2004500).
- Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020;382(8):727-733.
- Han H, Yang L, Liu R, et al. Prominent changes in blood coagulation of patients with SARS-CoV-2 infection. *Clin Chem Lab Med*. published online: March 16, 2020 (doi:10.1515/cclm-2020-0188).
- Li B, Yang J, Zhao F, et al. Prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China. *Clin Res Cardiol*. published online: March 11, 2020 (doi:10.1007/s00392-020-01626-9).
- Tellier R, Li Y, Cowling BJ, Tang JW. Recognition of aerosol transmission of infectious agents: a commentary. *BMC Infect Dis*. 2019;19(1):101.
- Brindle M, Gawande A. Managing COVID-19 in surgical systems. *Ann Surg*. published online: March 23, 2020 (doi:10.1097/SLA.0000000000003923).
- World Health Organization. Rational Use of Personal Protective Equipment for Coronavirus Disease (COVID-19): Interim Guidance, February 27, 2020. <https://apps.who.int/iris/handle/10665/331215>.
- Fraser JF, Arthur A, Chen M, et al. Society of Neurointerventional Surgery Recommendations for the Care of Emergent Neurointerventional Patients in the Setting of COVID-19, April 2, 2020. Society of Neurointerventional Surgery. <https://www.snisonline.org/wp-content/uploads/2020/03/SNIS-COVID-Stroke-Protocol.pdf>.
- Ti LK, Ang LS, Foong TW, Ng BSW. What we do when a COVID-19 patient needs an operation: operating room preparation and guidance. *Can J Anaesth*. published online: March 6, 2020 (doi:10.1007/s12630-020-01617-4).
- Gratton J, Tovey E, McLaws ML, Rawlinson WD. The role of particle size in aerosolised pathogen transmission: a review. *J Infect*. 2011;62(1):1-13.
- Wax RS, Christian MD. Practical recommendations for critical care and anesthesiology teams caring for novel coronavirus (2019-nCoV) patients. *Can J Anaesth*. published online: February 12, 2020 (doi:10.1007/s12630-020-01591-x).
- Peng PWH, Ho PL, Hota SS. Outbreak of a new coronavirus: what anaesthetists should know. *Br J Anaesth*. published online: February 27, 2020 (doi:10.1016/j.bja.2020.02.008).

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