Special Report

Protected Code Stroke

Hyperacute Stroke Management During the Coronavirus Disease 2019 (COVID-19) Pandemic

Houman Khosravani, MD, PhD; Phavalan Rajendram, MD;
Lowyl Notario, MSc; Martin G. Chapman, MD; Bijoy K. Menon, MD, MSc

Background and Purpose—Hyperacute assessment and management of patients with stroke, termed code stroke, is a time-sensitive and high-stakes clinical scenario. In the context of the current Coronavirus Disease 2019 (COVID-19) pandemic caused by the SARS-CoV-2 virus, the ability to deliver timely and efficacious care must be balanced with the risk of infectious exposure to the clinical team. Furthermore, rapid and effective stroke care remains paramount to achieve maximal functional recovery for those needing admission and to triage care appropriately for those who may be presenting with neurological symptoms but have an alternative diagnosis.

Methods—Available resources, COVID-19-specific infection prevention and control recommendations, and expert consensus were used to identify clinical screening criteria for patients and provide the required nuanced considerations for the healthcare team, thereby modifying the conventional code stroke processes to achieve a protected designation.

Results—A protected code stroke algorithm was developed. Features specific to prenotification and clinical status of the patient were used to define precode screening. These include primary infectious symptoms, clinical, and examination features. A focused framework was then developed with regard to a protected code stroke. We outline the specifics of personal protective equipment use and considerations thereof including aspects of crisis resource management impacting team role designation and human performance factors during a protected code stroke.

Conclusions—We introduce the concept of a protected code stroke during a pandemic, as in the case of COVID-19, and provide a framework for key considerations including screening, personal protective equipment, and crisis resource management. These considerations and suggested algorithms can be utilized and adapted for local practice. **(*Stroke*. 2020;51:00-00. DOI: 10.1161/STROKEAHA.120.029838.)**

Key Words: algorithms ■ consensus ■ COVID-19 ■ pandemics ■ stroke

Stroke

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Timely assessment of patients with stroke for hyperacute treatments such as thrombolysis and thrombectomy impact functional outcomes and mortality of patients with stroke. Furthermore, stroke remains a medical emergency even during a pandemic. Optimizing outcomes matter even more in these times as patients affected with severe stroke require hospitalization and may potentially be at greater risk of in-patient morbidity and mortality. Factors that affect outcomes in patients with stroke can include exposure to in-hospital pathogens, resource constraints impacting diagnostics, acute treatment, and poststroke care such as rehabilitation. Patients with stroke who require hospitalization during this pandemic are at an increased risk of suboptimal outcomes. These patient-specific considerations require balancing alongside the safety of healthcare professionals who are engaged in triage, rapid assessment, and treatment of patients during the hyperacute epoch.

Code stroke is a term used to prioritize the hyperacute assessment and care of a patient presenting with signs and symptoms concerning for stroke. The word code brings forward a sense of nuance with measured urgency without compromising precision in diagnosing and treating patients with stroke.

Currently, in the setting of the Coronavirus Disease 2019 (COVID-19) pandemic, similar medical emergencies such as cardiopulmonary arrest (code blue) are being modified to the protected designation to provide an additional layer of protection for healthcare professionals and patients. These measures include the use of personal protective equipment (PPE) and modifications to human performance factors in relation to triage processes, team member role designation, and dynamics while caring for patients during a protected code. There are also particular equipment considerations and early need for clinical actions. In light of mounting case volumes and

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From the Division of Neurology, Department of Medicine, Sunnybrook Health Sciences Centre, University of Toronto, Canada (H.K., P.R.); Sunnybrook Health Sciences Centre, Lawrence S. Bloomberg Faculty of Nursing, University of Toronto, Canada (L.N.); School of Nursing, McMaster University, Hamilton, Canada (L.N.); Department of Critical Care Medicine, Sunnybrook Health Sciences Centre, Interdepartmental Division of Critical Care Medicine, University of Toronto, Canada (M.G.C.); and Department of Clinical Neurosciences, Radiology, and Community Health Sciences, Cumming School of Medicine and the Hotchkiss Brain Institute, University of Calgary, Canada (B.K.M.).

Correspondence to Houman Khosravani, MD, PhD, Division of Neurology, Sunnybrook Health Sciences Centre, Room H335, 2075 Bayview Ave, Toronto, ON M4N 3M5, Canada. Email houman@stroke.dev

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regional shortages of PPE, triage strategies need to be in place for efficacious and high yield deployment of PPE. Herein, we outline key aspects to consider when developing a local protected code stroke (PCS) algorithm during these trying times.

Screening

Modern stroke care adheres to the hub-and-spoke model with regional and comprehensive stroke centers caring for patients with hyperacute stroke and offering thrombolysis and/or thrombectomy as appropriate. Patients are brought in from the field by paramedics, arrive directly to the hospital as walk-ins, or are transferred from other hospitals. During nonpandemic operations, paramedics in the field follow standardized protocols, as per local regional practice guidelines to determine when a code stroke is activated, thereby redirecting or transporting the patient to the nearest designated stroke centre.[1] The aim is to identify patients with acute stroke while excluding other immediate life-threatening conditions that would warrant transfer to the nearest hospital, such as compromised airway/breathing, seizure, or hypoglycemia. It is important to note that not all transfers for evaluation arrive directly to the emergency department. For some centers, patients arrive directly to an inpatient setting such as a specialized unit. Nevertheless, these screening measures are applicable independent of modality of arrival.

The COVID-19 pandemic necessitates additional screening completed by paramedics, when possible, and should include an infection control screen and travel history screen. As community transmission becomes more established, screening for travel will rapidly not be a value-add on its own but does increase risk of infectious contacts. Herein, we include travel history as it is conceivable that a patient with recent travel may present with neurological symptoms, without infectious symptoms, as a manifestation of COVID-19. Future studies will shed light on the overlap between COVID-19 and neurological presentations and this caveat may require re-evaluation.

Current data suggest that the virus responsible for COVID-19, the SARS-CoV-2 virus, is transmitted primarily via respiratory droplets.[2] Most cases of COVID-19 report respiratory symptoms associated with viral illness. Case reports suggest involvement of other systems, such as enteric or neurological, along with respiratory illness is also possible.[3,4] An infection control screen should assess for the following constellation of signs and symptoms: fever, cough, chest pain, dyspnea, headache, myalgias, and gastrointestinal symptoms including vomiting and diarrhea. Travel history screening should assess for recent (≤14 days) travel abroad or contact with someone who has travelled abroad. Given the widespread global transmission of SARS-CoV-2 and rising numbers of community transmission, travel to any international country should be deemed positive. At this time, if the infection control screen and/or travel history screen are positive, a PCS should be activated. Screening criteria are subject to change as the pandemic progresses.

The above recommended screening may not always be feasible—patients may not be able to reliably communicate due to stroke symptoms and family members may not be present on scene. Other clinical features such as decreased level of consciousness can also be considered to trigger a PCS. In these cases, continue with a PCS until such screening can be reliably completed or COVID-19 ruled out with formal testing. Screening should be completed within hours of arrival using all available collateral sources of information.

For patients being transferred from other health facilities, an infection control screen and travel history screen should be completed and communicated before transfer. If this has not been completed before transfer, continue with a PCS until such screening can be reliably completed or COVID-19 ruled out with formal testing. We re-emphasize the need for communication across sites before patient transfer and consistent implementation of local screening protocols as standard procedure. Local and regional practice recommendations should be adhered to.

Protected Code Stroke

The appropriate use of PPE by all team members is the cornerstone of the PCS framework (Figure 1). For a routine PCS, contact and droplet precautions should be used.[5,6] This requires a full-sleeved gown, surgical mask, eye protection (face shield and/or goggles), and gloves. Head covering is currently optional in some protocols. Ideally, extended cuff gloves should be used to overlap with the cuffs of the gown to minimize potential breaches in coverage. Precautions should be upgraded to include airborne precautions, including a fit-tested N95 respirator when there is an aerosolizing procedure. Aerosol-generating medical procedures that may be encountered during a code stroke include oropharyngeal/nasal (open) suctioning, bag-valve-mask ventilation, and intubation. Other aerosol-generating medical procedures include chest compressions, noninvasive positive pressure ventilation, and nebulization; CPR is a highly aerosol-generating procedure. Less common procedures include bronchoscopy and jet-flow endotracheal ventilation. These procedures should be deferred if possible, during the hyperacute phase. Airborne precautions must be used in the context of a cardiac arrest. Patients on routine modes of ventilation while on a closed circuit do not routinely require airborne precautions unless the circuit is interrupted for provision of care. For patients who arrive intubated, we do not recommend early extubation even if their neurological status improves during the hyperacute assessment phase as this increases the risk for aerosolization; recommend extubation in a controlled setting. It should be noted that nebulization of medications, CPAP, BiPAP, and nasal High Flow therapy should necessarily be avoided given the associated increased risk of aerosolization.[6,7] When possible, avoid acute placement of nasogastric tubes as these also increase the risk of aerosolization.

We recommend placement of a surgical mask on the nonintubated patient, after securing PPE for all team members. This mask should remain on the patient during transportation to, during, and back from imaging if the patient is able to tolerate. Supplemental oxygen with devices such as nasal prongs can be applied underneath the surgical mask. For patients proceeding onward to the neuroangiography suite, similar precautions for both patient and teams should be utilized with appropriate inter-team communication.

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Protected CODE STROKE (PCS)

** Screening Prior to Code Stroke**

- **On Pre-notification**
  - Is the patient exhibiting any infectious symptoms (Infection Control Screen)?
    - Fever, cough, chest pain, dyspnea, headache, myalgias, emesis/GI symptoms
  - Is there a close contact with infectious symptoms?
  - Does the patient or a close contact have a travel history?
  - **ANY of the above are POSITIVE?** → proceed as a **PCS**

- **Historical and Examination Features**
  - NO or POSITIVE Infection Control Screen?
  - Unclear history? Patient unable to communicate?
  - Decreased level of consciousness? presyncope/syncope?
  - History or examination features suggestive of an alternate (non-stroke) diagnosis?
    - **ANY of the above are TRUE?** → proceed as a **PCS**

** Protected Code Stroke **

- **Use Personal Protective Equipment (PPE) and Place a Mask on the Patient**
  - **(1) Use Droplet/Contact PPE:** full-sleeved gown, surgical mask, eye protection and gloves (ideal to use extended cuff gloves)
    - Is there **Aerosolization?** e.g. oropharyngeal/nasal (open) suctioning, intubation, non-invasive ventilation, Code Blue and/or CPR
      - **YES to Aerosolization?** → use **Airborne/Droplet/Contact PPE:** full-sleeved gown, N95 mask, eye protection and gloves (ideal to use extended cuff gloves)
  - **(2) Place a surgical mask on the non-intubated patient (after securing your own PPE)**
    - Mask should stay on the patient during transport to and from imaging
  - **Is the patient obtunded? Needing high FiO_2 (> 0.5)? Needing CPAP, BiPAP, Nasal High Flow therapy, or Bag-Valve-Mask ventilation?**
    - **YES to ANY?** → Consider **EARLY** intubation, Consult ED/ICU physician for airway management prior to transport to imaging

- **(3) Use Crisis Resource Management**
  - Do Not Rush inside the resuscitation room, "slow-down when you should"
  - Designate a **Safety Leader to monitor PPE donning/doffing**
  - Role designate your team and avoid crowding (ideally perform a pre-brief)
  - Ensure PPE is donned by all team members before starting **PCS**
  - Avoid Contamination of other hospital environments en-route to imaging and back

Patient from the field (EMS/direct to ED) Infection Control Screen POSITIVE and/or Travel History POSITIVE	Patient transferred from another facility WITHOUT: Infection Control Screen and/or Travel History Screening	Unclear/Unable to provide History, ANY Historical/Exam features suggestive of alternate diagnosis

Physician Discretion and Clinical Judgement

Protected Code Stroke

Figure 1. Protected code stroke (PCS) framework. Two key sections are outlined: screening and PCS operational parameters. These parameters are use of personal protective equipment (1) with and without aerosol-generating medical procedures, placing a surgical mask on the nonintubated patient (2), and utilization of crisis resource management principles (3).

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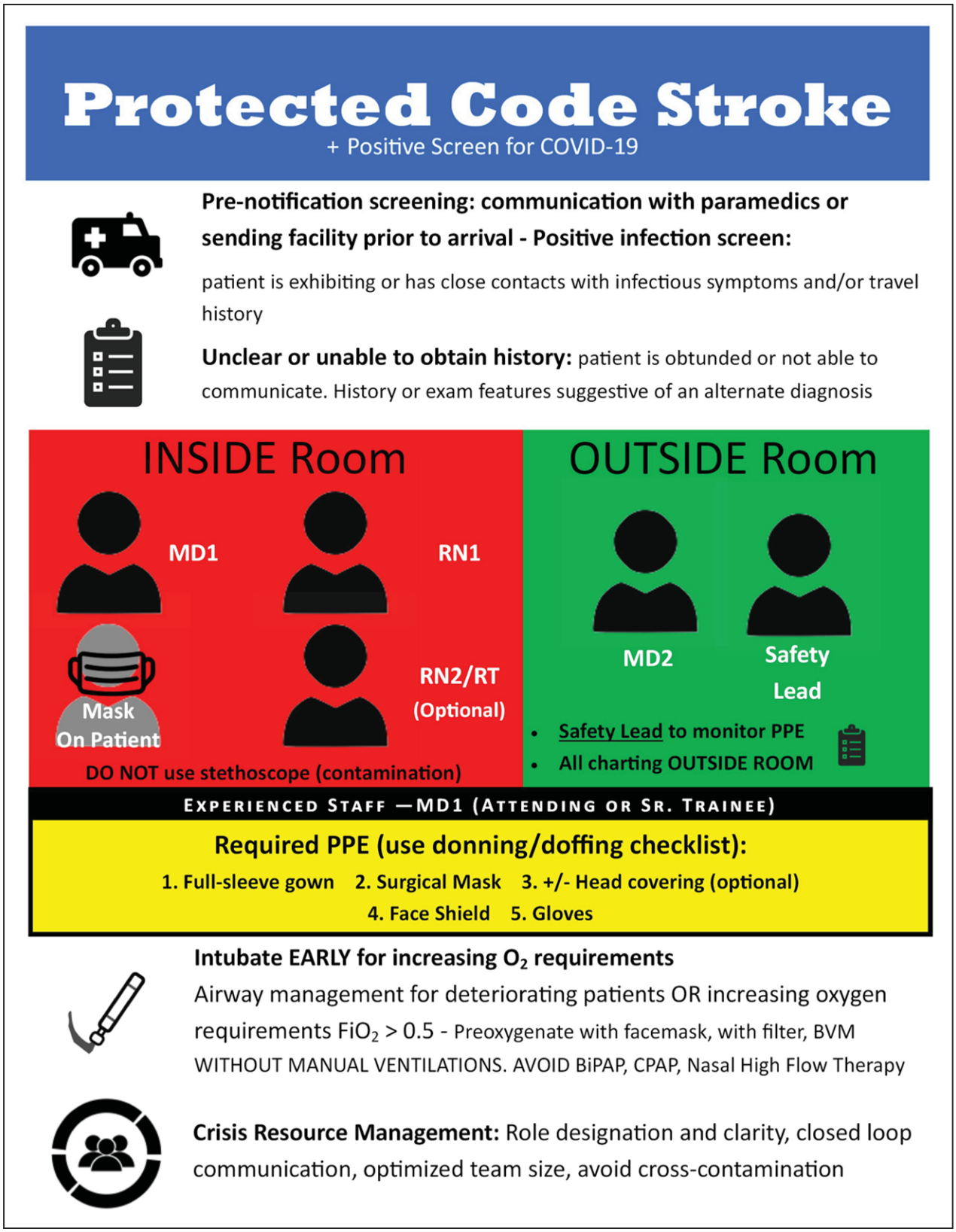

Figure 2. Suggested approach to team designation in a protected code stroke (PCS). Minimize team members in the resuscitation room—use a lean team approach. MD1 should be either an attending, fellow, or experienced trainee able to effectively obtain an National Institutes of Health Stroke Scale. In some cases, 2 RNs may be required for patient care. Any team member can be the designated Safety Lead (including RN, RT, additional MD, or other staff with knowledge of donning and doffing). The safety lead ensures proper technique and inspection of the equipment. When present, MD2 or alternate can gain collateral history through existing health records and family members. Required personal protective equipment (PPE) is as described, fit-tested N95 masks should be used for members inside the room if aerosol-generating medical procedures are occurring. The PCS team can proceed with the patient to imaging before doffing with the safety lead facilitating transit (to and from imaging) and PPE procedures BiPAP indicates bi-level positive airway pressure; BVM, bag-valve-mask; and CPAP, continuous positive airway pressure.

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In cases where the patient is obtunded or requires high fractions of inspired oxygen (FiO_2 >0.5), we recommend early consultation with an ED or intensive care unit physician for airway management. For the above, local and regional practice recommendations should always be followed. As the COVID-19 situation evolves, there are resources that provide up-to-date information for healthcare providers. These include the WHO (World Health Organization, https://www.who.int/emergencies/diseases/novel-coronavirus-2019# and https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance), and the CDC (Centers for Disease Control and Prevention, https://www.cdc.gov/coronavirus/2019-ncov/hcp/index.html).

Training

The potential for a breach in viral protection during the process of donning and doffing PPE is significant. Simulation training, especially in-situ, can alleviate the anxiety of the situation and reduce safety threats.[8]

Crisis Resource Management

Crisis resource management refers to the nontechnical aspects of teamwork in a crisis situation.[9] With respect to the PCS, there are numerous factors at the level of the individual, team, and environment that affect the success of the PCS. In these times, slower and careful may be better. When there is prenotification of an incoming code stroke, a prebrief should be carried out to clearly designate roles and avoid overcrowding with nonessential team members. Establishing protocols to limit team member aggregation and redundancy within the resuscitation and adjacent areas is a positive measure to reduce exposure of additional team members (Figure 2).

All team members should don necessary precautions before initiation of the PCS. Each code team should always assign one member of the team to observing donning/doffing for all members (Safety Leader, Figure 2). Before donning PPE, hand hygiene should be performed. This is followed by putting on a gown, mask/respirator, eye protection, and gloves, in that order. When doffing PPE, gloves and gown should be removed simultaneously followed by immediate hand hygiene. Avoid contamination of self, others, and the environment. Remove the most heavily contaminated items first. Eye protection and mask/respirator should then be removed followed by immediate hand hygiene once again. Reduce frequency of assessments to what is most essential. For example, avoid exam maneuvers that increase repeat contact between provider and patient such as finger-nose-finger and repeat assessments such as for motor and speech. Minimize the number of entries and exits from the patient's room. The prevailing crisis resource management philosophy is to have designated team members perform designated tasks so as to avoid the frequency of contact within team members and the patient while preserving efficacy and quality of care. This means having a designated safety leader and a designated clinical assessment lead (ie, MD1 in Figure 2) at each PCS.

Team members not in direct contact with the patient can be designated tasks such as gathering of additional information from electronic data sources and/or being safety leads. Witnesses and family members should also be screened. It is advisable to collect information from them over phone if possible, especially in the face of restrictions to visitation.

A lean team composition is best, and this philosophy should be adhered to in cases where the patient is unstable requiring additional advanced resuscitation measures, which may cause aerosolization.

Concluding Remarks

Clinical assessment and intervention during the hyperacute stroke phase have unique challenges during the COVID-19 pandemic. There are challenges to maintaining high quality care and promoting the best chance for recovery, while at the same time preventing transmission of pathogens to team members or other patients. Vigilant screening processes, proper adherence to established infection prevention and control measures, and a coordinated team response all contribute to a safe and resilient clinical stroke team during these challenging times.

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Disclosures

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