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ABSTRACT

SUMMARY: A health care crisis such as the coronavirus disease 2019 (COVID-19) pandemic requires allocation of hospital staff and resources on short notice. Thus, new and sometimes less experienced team members might join the team to fill in the gaps. This scenario can be particularly challenging in endovascular stroke treatment, which is a highly specialized task that requires seamless cooperation of numerous health care workers across various specialties and professions. This document is intended for stroke teams who face the challenge of integrating new team members into endovascular stroke-treatment workflows during the COVID-19 pandemic or any other global health care emergency. It discusses the key strategies for smooth integration of new stroke-team members in a crisis situation: 1) transfer of key knowledge (simple take-home messages), 2) open communication and a nonjudgmental atmosphere, 3) strategic task assignment, and 4) graded learning and responsibility. While these 4 key principles should generally be followed in endovascular stroke treatment, they become even more important during health care emergencies such as the COVID-19 pandemic, when health care professionals have to take on new and additional roles and responsibilities in challenging working environments for which they were not specifically trained.

ABBREVIATIONS: COVID-19 = coronavirus disease 2019; EVT = endovascular treatment; ICU = intensive care unit

The coronavirus disease 2019 (COVID-19) pandemic requires allocation of hospital staff and resources on short notice. As a consequence, new and sometimes less experienced team members might join the team to fill in the gaps. This scenario also applies to endovascular stroke treatment (EVT) workflows in the neuroangiography suite and post-EVT stroke care in the neuro-intensive care unit (Neuro-ICU) and stroke unit. There are several reasons why new members might join EVT teams. For example, stroke team members with ICU experience might be redeployed to an ICU and have to be replaced, or team members might be quarantined because they had close contact with a patient with COVID-19. Integrating new staff into EVT workflows is particularly challenging, given the time-critical nature of the disease, the need for seamless interdisciplinary and interprofessional cooperation, and the highly specialized skill sets of different team members.

This document is intended for stroke teams who face the challenge of integrating new staff into their EVT workflows during the COVID-19 pandemic or any other global health care emergency. It discusses strategies for smooth integration of new stroke-team members into EVT workflows in a crisis situation in 3 different settings: 1) the neuroangiography suite, 2) the Neuro-ICU ward, and 3) the stroke unit. The 4 overarching principles are the following: 1) transfer of key knowledge (simple take-home messages), 2) open communication and a nonjudgmental atmosphere, 3) strategic task assignment, and 4) graded learning and responsibility (Table 1). These 4 principles were developed during discussions among the members of the Emergency Neurovascular Care Committee, Cardiovascular and Stroke Nursing Council, and Telestroke and Neurovascular Intervention Committees and are mainly based on the joint experience of these committees. While it seems intuitively logical that those principles should generally be followed in clinical routine, and

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Table 1: Four key principles for integration of new staff in the stroke team during a health care crisis

Key Principle	Explanation/Implementation Strategy	Example
Transfer of key knowledge	New staff members should be primarily taught the key principles of their new working environment; these should be kept as brief and concise as possible in order not to overwhelm new staff	Neuroangiography suite: never walk in the room without a lead apron if a patient is on the table Neuro-ICU: never use a nasogastric tube until proper placement has been confirmed by a clinician (most commonly by a portable chest x-ray) Stroke unit: never feed a patient with stroke with dysphagia solid food until a swallow screen has been performed
Open communication and nonjudgmental atmosphere	New staff members have to feel comfortable telling core members if they do not feel comfortable doing a certain task and should not hesitate to ask for help or advice	A new staff member is told to monitor a patient on an alteplase infusion but does not know what symptoms or signs to look for; he or she explains this to the supervisor who reassigns the patient to a more experienced member and helps train the new member in this important task
Strategic task assignment	To avoid mistakes and treatment delays, new team members should execute tasks that are as closely related as possible to their core field of expertise	A nurse from the nephrology ward joins the stroke team; he or she is familiar with management of patient vitals but not with neuroangiography-specific terminology, eg, guidewire, balloon-guide catheter; thus, the task should be focused on management of patient vitals rather than procedure-specific peculiarities
Graded responsibility and learning	New staff members should gradually take on new tasks and responsibilities; they should feel comfortable performing a certain task and be capable of executing it safely before they are assigned additional, more complicated tasks	A schedule that pairs shifts of new team members with core team members; new team members are intermixed in new roles, as they have to learn new and complex tasks

particularly when caring for patients with acute stroke, doing so becomes even more critical during health care emergencies such as the COVID-19 pandemic because in such a situation, health care professionals have to take on new and additional roles and responsibilities in challenging working environments for which they were not specifically trained.

This document is also intended to encourage and empower working groups and institutions to create a framework for fast decision-making in crisis situations. In the following, we summarize key knowledge, unique characteristics (ie, tasks that are not ideal for new team members), and generic aspects (ie, tasks that lend themselves to new team members because they can extrapolate their experience from their previous working environment) for acute stroke care in 3 different settings: the neuroangiography suite (Table 2), Neuro-ICU (Table 3), and stroke unit (Table 4). We believe that in a crisis such as the COVID-19 pandemic, the focus should be on the generic aspects of stroke care: New team members can build on their pre-existing knowledge and skills and therefore contribute best to guideline-based stroke care.[1] Given their greater experience, it might be reasonable to primarily assign stroke and particularly EVT-specific tasks to the "core members" of the stroke team.

Neuroangiography Suite

The neuroangiography environment differs from the Neuro-ICU and stroke unit in that the patient with stroke remains there for only a short time. The risk of radiation exposure and handling of thrombectomy equipment is unique to the neuroangiography suite and yields additional challenges for new staff members. Furthermore, the neuroangiography staff has to execute several highly specialized technical tasks, such as positioning of the neuroangiography table and preparing the appropriate catheters and thrombectomy devices. Because chances of good outcome rapidly decrease with increasing time to reperfusion, workflows in the neuroangiography suite need to be maximally time-efficient. Examples of more generic tasks in the neuroangiography suite that would be suitable for new stroke-team members would be managing IV lines and blood pressure monitoring, while management of access-site complications, handling of endovascular devices, and reconstruction and labeling of angiography images should preferably be performed by key staff members (Table 2).

Neuro-ICU and Stroke Unit

Acute ischemic stroke treatment does not stop once the occluded vessel has been opened. Post-EVT care on the Neuro-ICU and stroke unit is critical to support patient recovery and prevent poststroke complications, which may erase the benefits of EVT.[2] Typical Neuro-ICU and stroke units share many similarities, whereas stroke units often represent a "step-down" environment in which patients may be at risk of requiring escalation to critical care. A collaborative multidisciplinary team environment with effective role

Table 2: Take-home points for new staff and unique-versus-generic aspects of stroke care in the neuroangiography suite

Most Important Teaching Points (Take-Home Points) for New Team Members	Unique Characteristics of the Neuroangiography Suite Environment (Not Ideal Tasks for New Team Members)	Generic Aspects of the Neuroangiography Suite Environment That Are Similar to Those in Other Medical Areas (Appropriate Initial Tasks for New Team Members)
Radiation awareness	Handling the groin puncture/access site	Blood pressure control,[1] hemodynamic monitoring
Boundaries between sterile vs nonsterile environment	Handling of catheters and devices	Management of IV lines
Location of key emergency drugs and equipment (epinephrine, oxygen, intubation kit), key/safe combinations in case some drugs (eg, opiates) are stored in a safe	Navigating the angiography machine	Clinical monitoring of the patient during the procedure
Phone numbers and schedule of neurointerventionalists, anesthesiologists, techs, and nurses on call	Image reconstruction and labeling	Documentation of patient status

Table 3: Take-home points for new staff and unique-versus-generic aspects of stroke care in the Neuro-ICU[a]

Most Important Teaching Points (Take-Home Points) for New Team Members	Unique Characteristics of the Neuro-ICU Environment (Not Ideal Tasks for New Team Members)	Generic Aspects of the Neuro-ICU Environment That Are Similar to Those in Other Medical Areas (Appropriate Initial Tasks for New Team Members)
Key components of neuromonitoring (vital signs, neurologic vital signs: pupils, Glasgow Coma Scale, intracranial pressure, NIHSS score, and so forth)	Resuscitation of unstable patient on initial presentation or with complications (eg, procedures surrounding airway management, status epilepticus treatment, intracranial pressure/herniation treatment, shock management, and so forth)	Monitoring vital parameters, level of consciousness, and respiratory parameters of nonintubated patients
Recognizing potential life-threatening complications	Monitoring patients on invasive or noninvasive positive pressure ventilation	Management of enteral feeds and IV fluids
Location of key equipment (code cart, difficult airway cart) and medications	Care and use of arterial and central lines, administration of vasopressors	Basic medication administration (may include managing alteplase/tenecteplase infusions, depending on background)
Team members and roles Chain of help, contact information (pager/phone)Examples: ICU buddy team member (RN, RT, pharmacist, and so forth), charge nurse, NCC/stroke fellow, NCC/stroke attending physician on call	Use and interpretation of multimodal neuromonitoring: Intracranial pressure monitors (external ventricular drain) Cerebral oxygenation monitors: continuous brain tissue oxygenation, near-infrared spectroscopy, jugular venous catheter Cerebral blood flow monitors Cerebral microdialysis Continuous electroencephalography	Placement and care of nasogastric/orogastric tube, IV line, Foley catheter, and so forth
Key elements of AIS/ICH/SAH management (see also Table 4), basic and advanced life support	Brain death assessments and management	Bathing, turning, mobilizing patients
	Organ donation: donation after circulatory death or donation after neurologic death	Charting/documentation of patient course
	Palliation, depending on circumstances; for patients with COVID-19, institutions may have unique policies for automatic do-not-resuscitate orders or care limitations that incorporate neurologic prognosis formation	

Note:—RN indicates registered nurse; RT, respiratory therapist; NCC, neurocritical care; AIS, acute ischemic stroke; ICH, intracerebral hemorrhage.

[a] For specific Neuro-ICU take-home points for the management of patients with acute ischemic stroke, intracranial hemorrhage, and subarachnoid hemorrhage, see Online Table.

delegation is the cornerstone of both the Neuro-ICU and stroke unit, with most roles being quite similar (Figure), with the notable absence of respiratory therapists in most stroke units. Neuro-ICU tasks that lend themselves to new team members are, for example, placement of nasogastric and orogastric tubes and Foley catheters, while more ICU-specific aspects such as vasopressor therapy and optimization of positive pressure ventilation parameters should ideally remain with the core team members

Table 4: Take-home points for new staff and unique-versus-generic aspects of stroke care on the stroke unit

Most Important Teaching Points (Take-Home Points) for New Team Members	Unique Characteristics of the Stroke Unit Environment (Not Ideal Tasks for New Team Members)	Generic Aspects of the Stroke Unit Environment Similar to Other Medical Areas (Appropriate Initial Tasks for New Team Members)
Recognizing an acute stroke, recurrent stroke, and abrupt neurologic deterioration of recent ischemic or hemorrhagic stroke	Monitoring a patient in the unit after receiving IV alteplase (involves watching for angioedema, bleeding, frequent neurologic vital sign monitoring, close blood pressure control, and so forth)	Obtaining/interpreting scheduled vital signs (temperature, blood pressure, heart rate, respiratory rate, oxygen saturation) and point-of-care blood glucose in patients
Managing infusions of alteplase for stroke or of heparin (eg, for intraluminal thrombosis, venous sinus thrombosis)	Being part of the acute stroke thrombolysis team (being comfortable with the "code stroke" and mixing alteplase)	Foley catheter insertion, urinary dipstick testing, and identification of potential urinary tract infection
Grossly identifying patients who are potentially aspirating versus those safe to swallow	Managing a patient at risk of malignant middle cerebral artery or cerebellar stroke (involves closely watching for neurologic deterioration and liaising with stroke/neurosurgery team for potential decompressive craniectomy)	Managing the patient's routine medications and reconciling them with those taken preadmission
NG insertion, feeding, and NG medication administration	Managing a patient with a major intracranial hemorrhage (involves watching for emerging symptoms of hydrocephalus or major hematoma expansion that may warrant neurosurgical intervention or ICU transfer)	Caring for a patient in the subacute-to-chronic poststroke period with/without medical issues like urinary tract infection, cellulitis, or pressure ulcers
Performing a NIHSS bedside examination	Receiving a patient after thrombectomy (involves monitoring the groin puncture site or managing hematoma)	Evaluation and initial management of a patient with chest pain or shortness of breath (eg, poststroke myocardial infarction, aspiration pneumonia)
Pager or phone numbers and schedule of stroke fellows and neurologists on call	Receiving a patient after carotid endarterectomy (involves watching for reperfusion complications, lower cranial neuropathies interfering with swallowing)	Evaluation and initial management of a patient with deep vein thrombosis
Understanding basic stroke mechanisms for early secondary prevention	Defining a stroke mechanism through a sophisticated understanding of neurovascular anatomy, localization, and cerebrovascular syndromes	Working with patient and pharmacy to ensure proper dosing and administration of early secondary stroke prevention (eg, antithrombotics, statin therapy, blood pressure regimen, smoking cessation)

Note:—NG indicates nasogastric tube.

(Table 3). In the stroke unit, new staff might want to start with managing patients' routine medication and Foley catheter and IV-lines, while obtaining a detailed neurologic status such as the NIHSS would be a more suitable task for experienced team members (Table 4). Nevertheless, it would certainly be desirable for the newer team members to initiate structured training regarding stroke-specific tasks (eg, NIHSS score) under the guidance of pre-existent staff members as would be the local standard at that institution.

Simulation training ("dry" practice runs with a nurse or mannequin acting as the patient) can help to practice specific workflow steps, identify latent safety threats, and familiarize new team members with their new tasks.[3] Simulation team training has also been shown to improve team functioning—communication and cooperation of different members among a medical team.[4,5] This is particularly important for workflow in the neuroangiography suite because treatment delays at this stage will lead to delayed reperfusion and thereby directly affect patient outcome. It is important to establish continuous monitoring of treatment quality (eg, reperfusion quality and access site complications such as groin hematomas and infections following endovascular treatment) and workflow times (door-to-needle times, door-to-groin puncture times), particularly in a health care crisis, to ensure that treatment quality is maintained to the best of the ability of the system and to detect problems in EVT workflows and treatment quality early on, which grants the medical team the opportunity to intervene in a timely manner. One might be tempted to think that continuous performance monitoring for complex, multidimensional tasks involving numerous specialties as is the case in endovascular stroke treatment is impractical, but studies have repeatedly shown that team performance in medicine can be validly measured across complex settings and that doing so helps to improve treatment workflow.[6]

CONCLUSIONS

Endovascular stroke treatment reaches well beyond the neuroangiography suite and encompasses a wide range of specialties (neurology, neuroradiology, neurosurgery, anesthesia, intensive care) and designations (physicians [among them attendings, fellows, and residents], nurses, technologists, pharmacists, therapists, nutritionists, medical students, nurse practitioners, physician assistants), just to name a few. During the COVID-19 pandemic and other major health care emergencies, augmentation of staff from other areas may be required due to staff redeployment, staff exposures/required quarantines, and increased patient demands.[7] This carries the risk of decreasing the quality of EVT and post-EVT care.[8]

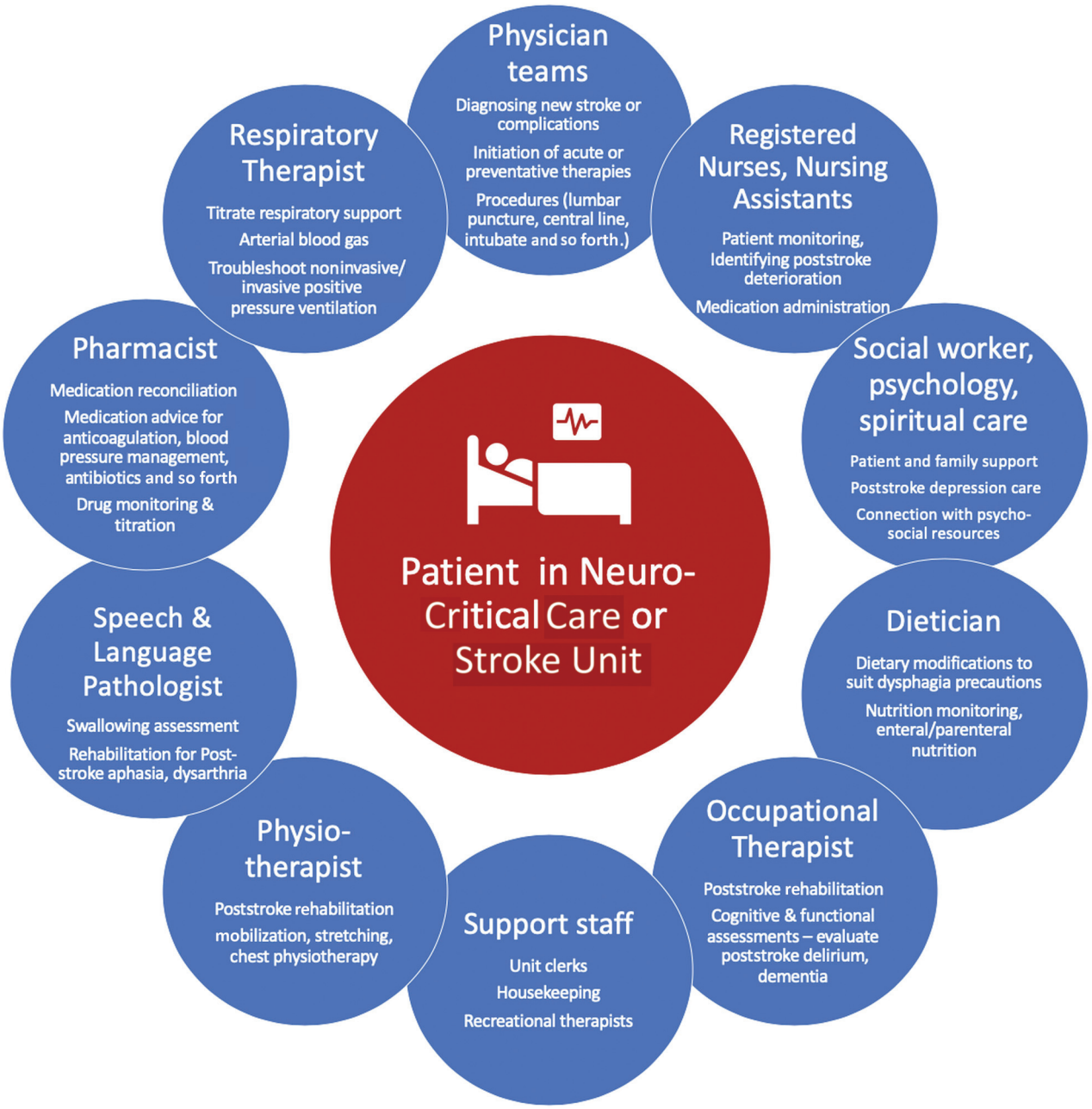

FIGURE. A model of patient-centered multidisciplinary care in the Neuro-ICU or stroke unit that is both helpful and reassuring for new staff members. The model is quite similar in both the neuro-critical care and stroke units with the notable exception of respiratory therapists who are often not part of medical stroke units. While this model is, of course, generalizable to nonstroke settings as well, some specific examples are illustrated to show how different members of the team may synergistically address a stroke-related problem. For example, in a patient with dysphagia, the nursing or physician team may be the first to notice a poststroke deterioration with the patient choking or coughing during a simple trial. This prompts the team to involve the speech and language pathologist who confirms poststroke dysphagia and recommends a temporary nasogastric tube, which is inserted by a nurse (perhaps with a new nursing team member observing this common task), with the dieticians then helping ensure that the nasogastric feed provided meets the patient's feeding requirements, potentially monitoring for a refeeding syndrome. These changes may be overwhelming for the patient and family, prompting the team to involve psychology to assess poststroke depression as well as social work and spiritual care to connect the patient and family to key resources.

Maintaining timely and comprehensive endovascular stroke care at a high quality during a health care crisis such as the COVID-19 pandemic is of utmost importance. Of note, the framework that was outlined in this article for integration of new members into existing stroke teams is based on personal experience of the American Heart Association/American Stroke Association Stroke Council Science Subcommittee members rather than objective data. Nevertheless, we would like to encourage individual stroke teams and their hospitals to collect data from their COVID-19 experience and publish them, because this would provide valuable information

to stroke teams and help them to further improve EVT workflows and post-EVT care in similarly challenging situations.

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