Stroke

AHA SCIENTIFIC STATEMENT

Care of the Patient With Acute Ischemic Stroke (Prehospital and Acute Phase of Care): Update to the 2009 Comprehensive Nursing Care Scientific Statement

A Scientific Statement From the American Heart Association

Endorsed by the American Association of Neuroscience Nurses

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ABSTRACT: The year 2020 was the year of the nurse, celebrating nurse scholarship, innovation, and leadership by promoting scientific nursing research, improving nursing practice, advancing nursing education, and providing leadership to influence health policy. As architects of stroke care, neuroscience nurses play a vital role in collaborating and coordinating care between multiple health professionals. Nurses improve accessibility and equity through telestroke, emergency medical services, and mobile stroke units and are integral to implementing education strategies by advocating and ensuring that patients and caregivers receive stroke education while safely transitioning through the health care system and to home. Stroke care is increasingly complex in the new reperfusion era, requiring nurses to participate in continuing education while attaining levels of competency in both the acute and recovery care process. Advanced practice nurses are taking the lead in many organizations, serving as prehospital providers on mobile stroke units, participating as members of the stroke response team, and directing stroke care protocols in the emergency department. This scientific statement is an update to the 2009 "Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke Patient." The aim is to provide a comprehensive review of the scientific evidence on nursing care in the prehospital and hyperacute emergency hospital setting, arming nurses with the necessary tools to provide evidenced-based high-quality care.

Key Words: AHA Scientific Statements ■ brain ischemia ■ health policy ■ nursing care assessment ■ nursing education research ■ reperfusion ■ stroke

The year 2020 was the year of the nurse, celebrating nurse scholarship, innovation, and leadership while commemorating the founder of modern nursing, Florence Nightingale. This recognition is timely as nurses demonstrate their immeasurable contributions and courage on the front lines caring for patients diagnosed with coronavirus disease 2019 (COVID-19). Although these are uncertain times, the spirit of nursing has not wavered, thrusting a spotlight on the heroic stories of healing, commitment, innovation, and leadership. Nurses conserve Nightingale's legacy by promoting scientific nursing research, improving nursing practice, advancing nursing education, and providing leadership to influence health policy. Scientific nursing guidelines provide a body of knowledge assisting nurses in addressing complex health needs and promoting quality care.

As the largest group of health care professionals, nurses span multiple areas of the health care infrastructure and play vital roles in advancing the health of families in their communities. Furthermore, as we learn more about health disparities, nurses are uniquely equipped to be advocates for patients of different

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socioeconomic, racial, gender, and sexual orientations. Because of the potential impact of nursing, in 2010, the Institute of Medicine published *The Future of Nursing: Leading Change, Advancing Health* report, addressing the critical role that nurses play in transforming health care.[1]

The neuroscience nurse has risen to the Institute of Medicine's challenge by using evidence-based improvement to guide care, participating in research, promoting interprofessional collaboration, and expanding education for patients, families, and health care professionals.[2] As one of the architects of the stroke care team, the nurse plays a vital role in collaborating and coordinating care between multiple health professionals. Nurses are integral to implementing education strategies by advocating and ensuring that patients and caregivers receive stroke education and are safely transitioned through the health care system and to home.

Stroke care is increasingly complex in the new reperfusion era, requiring nurses to participate in continuing education while attaining levels of competency in both the acute and recovery care process. Advanced practice nurses are taking the lead in many organizations, serving as prehospital providers on mobile stroke units (MSUs), participating as members of the stroke response team, and directing stroke care protocols in the emergency department (ED). This scientific statement is an update to the 2009 "Comprehensive Overview of Nursing and Interdisciplinary Care of the Acute Ischemic Stroke Patient."[3] The aim is to provide a comprehensive review of the scientific evidence on nursing care in the prehospital and hyperacute emergency hospital setting, arming nurses with important clinical tools to provide evidenced-based care. Recommendations for future research to guide nursing practice are also proposed.

PREHOSPITAL STROKE CARE: EMERGENCY MEDICAL SERVICES AND MSUs

Prehospital

The "time is brain" principle emphasizes the time-sensitive nature of early identification of patients with a suspected ischemic stroke and early intervention to prevent a delay in reperfusion that leads to irreversible tissue damage and poor patient outcomes.[4] Inequities related to emergency care access and knowledge of stroke warning signs remain poor, with the largest disparities occurring in women and underrepresented race and ethnic groups, contributing to delays in emergency medical services (EMS) activation and ED presentation.[5] Therefore, it becomes critically important that, when activated, prehospital professionals recognize stroke symptomatology, work quickly to obtain the required information, and safely deliver the patient to the appropriate acute care setting.

Table 1. D's of Stroke Care

Detection	Rapid recognition of stroke symptoms
Dispatch	Early activation and dispatch of EMS by calling 9-1-1
Delivery	Rapid EMS identification, management, and transport
Door	Appropriate triage to stroke center
Data	Rapid triage, evaluation, and management within the ED
Decision	Stroke expertise and therapy selection
Drug	Fibrinolytic therapy, intra-arterial strategies
Disposition	Rapid admission to stroke unit, critical care unit

ED indicates emergency department; and EMS, emergency medical services. Adapted from Jauch et al.[6] Copyright © 2010 American Heart Association, Inc.

Nurses have been at the forefront, providing extensive educational opportunities to prehospital providers, dispatchers, and community members to support the "D's of Stroke Care." The D's of Stroke Care (Table 1) have been identified as major steps in the diagnosis and treatment of stroke and highlight integral points where nurses facilitate time-sensitive stroke care.[6]

Detection

Nurses have historically played a role in educating the public on recognizing the warning signs and symptoms of stroke. Understanding the social determinants of health and targeting high-risk groups to tailor interventions are essential in improving individual response to stroke symptom recognition.[5] In fact, certified stroke programs are required to host yearly public awareness campaigns to meet certification standards. Programs directed at community awareness of stroke warning signs and symptoms and personal risk factors have been successful in venues such as elementary and middle schools (ie, Hip Hop Stroke and Stroke Heroes Act Fast); faith-based communities; local service organizations; festivals (ie, Stomp Out Stroke); sporting events (ie, Strides for Stroke and Strike Out Stroke); independent-living communities; barbershops; and sustained public education campaigns supported by state, health care, and national organizations such as the American Heart Association (AHA)/American Stroke Association. Familiarity with signs and symptoms of stroke enables the public to recognize when someone may be exhibiting stroke symptoms and rapidly activate EMS.[5]

Dispatch

Prehospital dispatch personnel, generally one of the first points of entry into the health care system, play an important role in the timely care and possible treatment options for the patient with a potential stroke.[6] The dispatcher should be trained to recognize when a caller may be requesting help for a person with a range of neurological deficits and have the ability to talk a caller through

Table 2. Prehospital Triage Factors

Distance to stroke-capable facility
Run times
Stroke designation tiers (CSC, TCS, PSC, ASRH)
Availability of services (MSU, ground transport, air transport)
Diversion status of facilities
Medical control system
Dispatch criteria
Public vs private EMS
Patient preference
Symptom onset
Stroke severity
Patient stability

ASRH indicates Acute Stroke-Ready Hospital; CSC, Comprehensive Stroke Center; EMS, emergency medical system; MSU, mobile stroke unit; PSC, Primary Stroke Center; and TSC, Thrombectomy-Capable Stroke Center.

the administration of a simple stroke evaluation scale such as the Cincinnati Prehospital Stroke Scale[7] or the Los Angeles Prehospital Stroke Screen[7] and to collect valuable information such as last known normal (LKN). The term last known well is used synonymously with LKN in the stroke literature. The writers have chosen to use LKN in this scientific statement.

The LKN must be established because this information becomes critical as a result of time constraints around treatment. This is best obtained from the patient if possible, but family, friends, and bystanders may have information to contribute. It is extremely important to make sure that everyone understands what is being asked. LKN means exactly that: what time or when the person was last known to be at baseline with the goal of determining time of symptom onset. It should not be interpreted as the time that the patient was found with symptoms because the onset of brain ischemia may have started before symptoms were recognized. LKN could be determined as an in-person encounter visualizing symptom onset or a conversation that would identify the last time the patient appeared normal.

Additional prehospital triage factors influencing both the initial dispatch and subsequent EMS routing of the patient with a suspected stroke are listed in Table 2. Use of global positioning systems and secure mobile platforms assists in navigating triage decisions for EMS to transport patients to stroke-capable facilities while providing timely transmission of information needed to assemble stroke teams and to prepare for the arriving patient.

Delivery: EMS Field Assessment

Assessment of a patient with suspected stroke in the field by EMS personnel should include airway, breathing, vital signs, a baseline neurological assessment, blood glucose, and cardiac monitoring. Concurrent with the assessment, collection of the patient's current medication lists (or bringing medication to the ED), establishment of LKN, and obtaining both family and witness contact information are critical[8]; these actions provide the necessary information for the ED practitioners to make expedited decisions on treatment eligibility.

It is not recommended that EMS personnel administer antihypertensive medications to lower blood pressure in the patient with a suspected stroke because there is concern about limiting perfusion to the ischemic tissue and worsening the stroke. Concern about significant elevations in blood pressure should be communicated to the EMS medical control per individual EMS protocol.[5]

The administration of a standardized stroke scale is recommended. Although others are available, the Cincinnati Prehospital Stroke Scale and the Los Angeles Pre-Hospital Stroke Scale are used frequently because they are the only prehospital validated tools.[7] These scales incorporate some combination of facial weakness and arm weakness and other items, depending on the scale. In addition, there are several numeric scales with varying cutoff points to identify stroke symptoms associated with large vessel occlusion (LVO) that assist with appropriate routing of these patients to mechanical thrombectomy (MT)–capable centers.[9] Future research is needed to develop a consensus on the best tools that should be used by prehospital providers.

Blood glucose is an important measure to assess for hyperglycemia/hypoglycemia and must be collected on all suspected patients with stroke symptoms. Transient hypoglycemia (blood glucose <60 mg/dL) may manifest as a stroke mimic with acute mental status changes, seizure, loss of consciousness, hemiplegia, and aphasia. EMS should rely on treatment recommendations based on national EMS clinical guidelines or consult with local protocols and medical direction to guide treatment. Symptoms usually resolve with prompt treatment of intravenous glucose.[5]

Door: EMS Routing

Nurses are commonly the communicating link between the prehospital team and the ED providers. In many cases, nurses receive the initial report and start the cascade of internal notifications to alert the stroke team. These early notifications establish workflows to reduce time to treatment and to improve patient outcomes.[10–12]

Triage recommendations should balance the benefits of early initiation of intravenous alteplase with early access to MT for patients with suspected LVOs. The Mission: Lifeline Severity-Based Stroke Triage Algorithm for EMS provides recommendations for on-scene assessments, including use of an LVO screening tool and considerations for both time to treatment and availability of regional stroke center resources.[8]

Nurses should be educated on EMS algorithms used in their communities because they may vary according to

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stroke center certification levels and availability of geographic resources. It is important to use all stroke centers such as Acute Stroke Ready Hospitals and Primary Stroke Centers to avoid overloading the MT-capable centers (Comprehensive Stroke Centers and Thrombectomy-Capable Stroke Centers) while supporting treatment closest to the patient's location.[13]

Mobile Stroke Units

Patients have better outcomes and are discharged home more often when treated early.[13,14] The mobile stroke concept grew from the idea of providing stroke treatment earlier in the stroke symptom onset, thereby reducing death and disability.[15–17] The MSU contains a point-of-care laboratory, computed tomography (CT) imaging capabilities, and a stroke team. The stroke team on board an MSU can look vastly different according to the staffing model. Many MSUs use telemedicine and staff a CT technician, a paramedic, and a nurse, whereas others do not have telemedicine capabilities and staff a CT technician, a paramedic, and an advanced practice provider. Together, the point-of-care laboratory, a CT scanner capable of performing a noncontrast brain CT, and the specialized stroke team can speed diagnosis, treatment, and triage, increasing treatment opportunities.[18]

Although the reduction in time to thrombolysis has been the focus of the MSU,[10] the delivery of a patient to the most appropriate stroke center has become increasingly important.[19] Prehospital imaging and neurovascular assessment performed by a specialist ensure that patients are both treated at the earliest possible time and delivered to a center capable of supporting acute ischemic stroke (AIS) treatment.[20]

Although the noncontrast CT can rule out hemorrhage for thrombolysis administration, many MSUs have the capability of obtaining a CT angiography (CTA). The CTA can provide confirmation of LVO[19,20] and in many cases be accessed by neuro-interventionalists at treatment facilities to determine MT eligibility. Completing the imaging (CT and CTA) before hospital arrival ideally allows the MSU personnel the ability to bypass the ED and transport the patient directly to the interventional suite.[21] As a result, many MSUs have been successful in demonstrating reduced door-to-needle time and door-to-puncture time compared with traditional EMS transports.[22]

EMERGENCY MANAGEMENT AND TREATMENT

Emergency Departments

EDs are a critical entry portal for patients into a stroke system of care, and they are a requirement for organizations to meet standards outlined by Disease-Specific Care certification organizations.[23–25] In some regions in the United States, EDs may be free-standing (ie, not attached to a hospital) or may function as a satellite extension of a larger hospital ED. These facilities are typically located in suburban or rural communities and serve patients who might not have ready access to a larger hospital.

Although there are fundamental diagnostic resources required to qualify as an ED, variability exists in terms of patient volume, clinician and nursing staffing expertise, and the availability of specific interventional resources. EDs are usually designed with 2 entrances to accommodate ambulance arrivals and patients who arrive by private vehicle. Both locations support triage teams who perform initial assessments and assign an acuity score to patients during the initial phase of care.[26] These entrance options for patients presenting with acute stroke symptoms have implications for the important training and triage skills for the ED nurse. The nurse accepting a patient with a suspected acute stroke (aka stroke alert) from EMS will usually trigger a prehospital alert to the receiving team and the subsequent assignment of the patient to a higher-acuity section of the ED. Likewise, selected patients who are transferred from an outside hospital to a partner facility for a higher level of care may already have started a treatment plan or require continued treatment, and thus, their path trajectory may require specialty-specific resources. Patients who arrive by private vehicle (aka walk-ins) may not have had a formal evaluation by a medical professional. Therefore, the triage nurse must quickly assess the patient's presenting symptoms and consider activating the stroke response team.

Data: Triage

The traditional documented arrival time or door-in time of a patient with suspected AIS at triage is a key starting point for tracking time-sensitive metrics that describe processes and treatment options for suspected AIS cases. Arrival in the ED marks time 0 for the clock to begin tracking the evaluate-to-treat processes for patients with suspected AIS who may be candidates for intravenous thrombolytics, MT, or combination of both. However, with the development of MSUs, time 0 is documented as the time that the MSU arrives on scene and begins the immediate patient assessment.

It is recommended that skills training for triage personnel include recognizing both typical and atypical symptoms of stroke and have an agreed-on time window (from LKN) within which to activate the stroke response team.[27,28] ED nurses perform a pivotal role in the triaging process for patients with suspected AIS brought in by EMS and for patients who access ED care via private vehicle. Competency and ongoing stroke education should be required for all triage staff and should complement the use of stroke screening tools analogous to

Table 3. Triage Scoring Systems Used to Determine Resources

ESI and Canadian Triage Scoring System scales*	
Level I	Shock, evidence of end-organ failure
Level II	Evidence of borderline end-organ failure
Level III	Vital signs are within the upper or lower portion of the normal range
Level IV or V	Normal vital signs
Australasian Triage Scale: descriptors for categories†	
1	Immediately life-threatening
2	Imminently life-threatening or important time-critical
3	Potentially life-threatening, potential adverse outcomes from delay >30 min, or server discomfort or distress
4	Potentially serious; potential adverse outcomes from delay >60 min; or significant complexity, severity, discomfort, or distress
5	Less urgent or dealing with administrative issues only

ESI indicates Emergency Severity Index.

*Adapted from Gilboy et al.[29]

†Adapted from Considine et al[30] with permission from the American College of Emergency Physicians. Copyright © 2003 Elsevier.

those used in the prehospital setting.[9] The time-sensitive acute stroke treatment options warrant highly skilled nurses to understand the elements of the prehospital stroke screening tools used by the local EMS agencies that justify a prehospital stroke code activation. Similarly, triage nurses must rapidly recognize and evaluate patients who arrive by modes other than ambulance (ie, walk-ins) and present with 1 or more of a multitude of suspected stroke symptoms. Triage nurses may be the first team to initiate and mobilize the stroke code team.[29] The Emergency Severity Index (ESI) and the Australasian Triage Scale[30] (Table 3) are 2 scales that may be assigned to a patient with AIS to define the patient's acuity and the anticipated resources needed during their ED care, which in many systems correlates with patients being triaged to a higher-acuity area (ie, resuscitation room, critical care side of the ED). However, given the circumstances in a stroke code whereby the patient acuity and level of care may change dramatically, initial ESI assignments for patients with suspected AIS may not be associated with actual patient acuity after the rapid evaluation. Of note, our group agrees that it is reasonable to suggest that stroke centers use the prehospital assessment to delineate ESI levels. Instances suggesting an LVO or eligibility for reperfusion therapies merit strong consideration for being triaged as an ESI level 1. The system of care should also function in the same manner for patients with stroke alert who are at ESI level 1 or 2 with regard to time-to-imaging and time-to-intervention metrics.

Decision: Stroke Expertise

An organized protocol that facilitates the early identification of patients with acute onset of neurological deficits and identifies when the patient was last normal should define the stroke code process. The currently accepted time window of "24 hours from the time the patient was last known to be at his/her baseline" reflects the time period for effective treatment options for AIS and thus dictates the stroke code activation window (Figure).[31]

Activation of a stroke team can be initiated before patient arrival by EMS (if there has been a field call with a reported suspected stroke case) or after the triage assessment at the time of arrival.[5] Stroke response teams may consist of ED physicians, nurses, laboratory/radiology personnel, and other key ancillary staff (ie, registration). Stroke team activation may be initiated before arrival by EMS or at arrival by triage nurses after their initial evaluation of the patient. Some stroke programs also have created unique roles such as a stroke responder, who may be a nurse or advanced practice provider with advanced skills in the neurological evaluation whose primary responsibility is to coordinate the stroke code. Alternatively, some hospitals may have a dedicated stroke response team that includes neurology residents/fellows or a vascular neurologist, whereas others may activate telestroke neurologists.

In a traditional model, the first 1 to 5 minutes after patient arrival includes an initial rapid primary survey by the ED physician ensuring that there is no compromise of airway, breathing, and hemodynamics. When appropriate, a secondary survey evaluates the patient for resultant traumatic injuries (such as a fall or motor vehicle accident) that may have occurred before arrival. The AHA's Target: Stroke Phase III describes a currently promoted practice that advocates for a "door straight to CT imaging" best practice model in which the patient is directed to the CT imaging department before completing a full history, physical examination, or other initial diagnostic testing.[32] It is reasonable in some systems to do this while the patient is still on an EMS stretcher if there is an organized direct EMS-to-CT protocol and the patient is stable per EMS report. This care model allows the rapid acquisition of imaging to assess for an intracranial hemorrhage, which immediately rules out intravenous thrombolytics as a treatment option.

Stroke order sets facilitate and standardize the order entry process for diagnostic studies and rapid neuroimaging.[5] With the current time goal to treatment being pushed to <30 minutes, the stroke order set is usually initiated as soon as the patient is registered. The only assessment required by guidelines before the initiation of thrombolytic agents is a blood glucose level, and this is often available from the EMS field evaluation. A noncontrast CT mentioned earlier is required before the initiation of revascularization interventions, principally to exclude intracerebral hemorrhage or subarachnoid hemorrhage. Additional studies such as a chest x-ray and 12-lead ECG should be deferred until after the completion of neuroimaging.

Emergency Department Code Stroke Pathway

Priorities:	EMS Pre-Notification	0 to 10 minutes	10 to 20 minutes	20 to 30 minutes	30 to 45 minutes	45+ minutes
	Activate Code Stroke, Register Patient & Enter Orders	Rapid Triage, Brief Exam, Non Contrast CT Scan	Advanced Imaging, Full History, NIHSS, Labs Drawn & Sent	Determine IV eligibility (Goal: Door to Alteplase ≤30 min)	Determine IA eligibility (Goal: Door to Groin Puncture ≤60 min)	Post-alteplase monitoring if given & transfer to NIR or inpatient unit
ED MD	☐ Obtain Name & DOB from EMS ☐ If last known normal (LKN) is ≤24 + ≥1 focal stroke s/s, **ACTIVATE CODE STROKE**. Include ETA, age, stroke s/s and LKN ☐ Activate ED Adult Stroke Initial Evaluation Orders	☐ Verify Blood Glucose result obtained by EMS (if <60mg/dL don't go directly CT) ☐ Brief Neuro Exam within 1st 10min If no pre-notification received: ☐ If LKN is ≤24 + ≥1 focal stroke s/s, **ACTIVATE CODE STROKE**. Include ETA, age, stroke s/s and LKN ☐ Activate ED Adult Stroke Initial Evaluation Orders	☐ Maintain SBP ≤185 and DBP ≤110 if reperfusion candidate ☐ Implement Hemorrhagic Stroke orders if needed based on CT results ☐ Manage Overall Care ☐ Brief update to patient/caregiver	☐ Maintain SBP ≤185 and DBP ≤110 ☐ Manage overall care, review labs, ECG ☐ Vital Signs: BP & HR ☐ Strict NPO ☐ Obtain 2nd IV for alteplase **If Alteplase Candidate:** ☐ Notify ED MD & NEU for BP ≥185/110 ☐ Begin mixing alteplase when advised by NEU MD ☐ Complete independent double check and waste excess ☐ Draw up bolus into syringe ☐ Administer bolus and infusion per order & protocol ☐ Implement post-alteplase Neuro assessment and VS protocol: ○ Q 15min x 2 hrs ○ Q 30min x 6hrs ○ Q 1 hr x 16 hrs	☐ Maintain SBP ≤185 and DBP ≤110 ☐ Manage overall care, review ECG ☐ For Alteplase treated patients: Maintain SBP ≤180 and DBP ≤105 ☐ Monitor for post-alteplase complications **If Alteplase Administered:** ☐ Continue post-alteplase Neuro assessment and VS protocol ☐ Monitor post-alteplase complications ☐ Nursing Bedside Dysphagia Screen: if pass may administer meds, obtain diet order; if fail STRICT NPO **If MT Candidate:** ☐ Transport to NIR, handoff to anesthesia/NIR nurse at bedside **If Intra-Arterial Candidate:** ☐ Complete advanced imaging, (if not done) ☐ Send final treatment decision and transport decision updates Code MT Pagers ☐ Communicate treatment plan to ED RN/MD ☐ Communicate treatment plan to Patient/Family ☐ Facilitate rapid transport to NIR to facilitate groin puncture by 60 minutes	☐ For Alteplase treated patients: Maintain SBP <180 and DBP <105 ☐ Monitor for post-alteplase complications **If Alteplase Administered:** ☐ Continue post-alteplase Neuro assessment and VS protocol ☐ Hang normal saline at same rate when alteplase complete to flush line ☐ Monitor post-alteplase complications ☐ Nursing Bedside Dysphagia Screen: if pass may administer meds, obtain diet order; if fail STRICT NPO ☐ Transfer to ICU/stroke unit when bed available (unless MT candidate) **If Alteplase not administered:** ☐ Nursing Bedside Dysphagia Screen: if pass may administer meds, obtain diet order; if failed STRICT NPO ☐ Transfer to stroke unit when available ☐ Write consult note/ H&P using template (include time seen, time of image(s) review, NIHSS) **If Alteplase given:** ☐ Consult Neuro ICU team & enter place patient in ICU or stroke unit bed order **If Alteplase not given:** ☐ ASA 300mg PR (if nursing bedside screen failed) ☐ ASA 325mg PO (if nursing bedside screen passed)
ED RN	☐ Obtain name & DOB from EMS ☐ If last known normal (LKN) is ≤24 + ≥1 focal stroke s/s, **ACTIVATE CODE STROKE**. Include ETA, age, stroke s/s and LKN ☐ Contact ED Registration for STAT registration: if no name/DOB available register as "Unidentified" or "Disaster" patient ☐ Nofity CT scan to receive room assignment ☐ ED RN (or pharmacist) obtains alteplase kit ☐ Obtain monitor & place on stretcher ☐ Obtain Stroke Resource Binder	☐ Rapid Triage ☐ Obtain Vital Signs from EMS monitor ☐ Notify ED MD for BP ≥185/110 ☐ Place ID band on patient ☐ Obtain Blood Glucose (if not done by EMS) & notify ED MD of results ☐ Transport to CT Scan on EMS stretcher If no pre-notification received: ☐ Contact ED Registration for STAT registration ☐ Obtain alteplase kit ***Note**: If no name/DOB available, patient should be registered as a "Unidentified" or "Disaster" Patient ***Note**: Registration SHOULD NOT delay CT Scan, patient may be registered after CT scan in emergencies	☐ Transport to assigned room ☐ Verify/initiate IV access (2 if possible) ☐ Draw Labs ☐ If patient is on warfarin obtain POC INR ☐ Send Labs with red 'Code Stroke Alert' ☐ Obtain POC Glucose ☐ Full set of Vitals, oxygen saturation ☐ Neuro Assessment ☐ Cardiac Monitoring ☐ Strict NPO ☐ Obtain & document patient weight ☐ Begin Stroke Narrator Documentation ☐ Initiate advanced imaging plan (if needed) ☐ If advanced imaging ordered, page 'possible Code MT' ☐ NIHSS & Determine focal/stroke related deficits ☐ Document ABCD2 score, follow TIA protocol ☐ Consult with Radiologist for final interpretation of NC Head CT Scan if needed ☐ Based on CT results and exam, determine inclusion, exclusion and warning criteria for IV alteplase. Finalize treatment plan no later than 20 minutes after patient arrival	☐ Review ECG, Lab Results (BG is only required test if not on anticoagulation and no history of blood dyscrasias) **If Alteplase Candidate:** ☐ Verify SBP ≤185mmHG and DBP ≤110mmHG. Treat if needed. ☐ Notify ED RN to begin mixing drug ☐ Review risks/benefits/ alternatives with pt/caregiver & provide education ☐ Communicate plan of care to ED MD/RN ☐ Use ED STROKE orderset to order alteplase ☐ Notify ED RN/Pharmacist when order is placed & verify dose with RN/Pharmacist ☐ Consult Neuro ICU team & enter place patient in ICU or stroke unit bed order	
Neurologist/Resident/Tele Neuro	☐ Receive 'Code Stroke' Page ☐ Respond to ED Triage to meet patient ☐ Order CTA as necessary if pt is a possible LVO Stroke/Code MT* If LKN 6-24 hours, consider CTP (perform at same time as CTA) *When CTA/CTP is ordered, place cerebral angiogram order and initiate Code MT Stroke Physician Workflow. Page Possible Code MT if LVO scale positive*	☐ Obtain history from EMS en route to CT ☐ Obtain family/witness contact info from EMS ☐ Determine advanced imaging plan (CTA, CTP) & place orders as needed - *DO NOT delay alteplase administration for advanced imaging* ☐ Initial NC Head CT read. Implement Hemorrhagic Stroke Pathway as needed ☐ If patient is on warfarin, notify RN to obtain POC INR If no pre-notification received: ☐ Receive Code Stroke Page and respond directly to ED/CT Scan, determine need for CTA/CTP				

PATIENT ARRIVES

Adapted courtesy of The University of North Carolina Comprehensive Stroke Center

Figure. Emergency department (ED) code stroke pathway.

ASA indicates acetylsalicylic acid; BG, blood glucose; BP, blood pressure; CT, computed tomography; CTA, computed tomography angiography; CTP, computed tomography perfusion; DBP, diastolic blood pressure; DOB, date of birth; EMS, emergency medical services; ETA, estimated time of arrival; HR, heart rate; H&P, history and physical; ICU, intensive care unit; ID, identification; INR, international normalized ratio; IV, intravenous; LIP, licensed independent practitioner; LKN, last known normal; LVO, large vessel occlusion; MT, mechanical thrombectomy; NC, non-contrast; NEU, neurology; NIHSS, National Institutes of Health Stroke Scale; NIR, neurointerventional team/suite; NPO, nothing by mouth; PIV, peripheral intravenous line; PO, orally; POC, point of care; PR, rectally; SBP, systolic blood pressure; s/s, signs/symptoms; STAT, immediately; TIA, transient ischemic attack; and VS, vital signs. Adapted courtesy of The University of North Carolina Comprehensive Stroke Center.[31]

Table 4. Nursing Pearls for Performing the NIHSS

Item	Pearls in performing	Score regardless	Aphasic patient	Comatose patient	Intubated patient
1a LOC responsiveness	May use painful stimuli			No response or reflexive to pain: Score=3	Assess LOC if not sedated/ paralyzed
1b LOC questions		Dysarthria, language barrier, trauma: Score=1	May write answers or can be given yes/no options No comprehension: Score=2	Score=2	Score=1
1c LOC commands	May pantomime or substitute 1-step commands	Patients with trauma, amputation, etc, should be given other 1-step commands		Score=2	Assess normally
2 Best gaze	May perform oculocephalic maneuver	Patients with isolated peripheral nerve palsy (CN III, IV, or VI): Score=1	Establish eye contact and move around the bed	Oculocephalic maneuver	Assess normally
3 Visual		Blindness from any cause: Score=3	Blink to threat	Blink to threat	
4 Facial palsy	May use painful stimuli or pantomime	Remove physical barriers that obscure face	Pantomime to encourage the patient	Check grimace to painful stimuli	
5 Motor arm	May pantomime Palms down Test each arm separately beginning with nonparetic arm No score for amputation or fusion		Place the patient's arm in starting position and encourage using urgency in the voice to hold in position	Reflexive posturing: Score=4	
6 Motor leg	May pantomime No score for amputation or fusion		Place the patient's leg in starting position and encourage to hold in position	Reflexive posturing: Score=4	
7 Limb ataxia	Test with eyes open No score for amputation or fusion	If blind, score from extended finger position to nose If visual field defect, test in intact visual field Hemiplegia: Score=0	Passively move the limb to show what is expected If cannot understand: Score=0	Untestable: Score=0	
8 Sensory	May use painful stimuli Only score sensory loss related to stroke		If patient cannot differentiate pinprick to demonstrate severe/total sensory loss: Score=0	Score=2	
9 Best language	Comprehension scored by scoring cards and information obtained in commands in the preceding examination	If visual loss, ask patient to identify objects placed in hand	Patient may write responses	Score=3	Patient may write responses
10 Dysarthria	May assess with any overt speech during conversation		Read words out loud and attempt to have patient repeat; if no intelligible speech or mute: Score=2	Score=2	Untestable: Score=0
11 Extinction and inattention	Observe for lack of awareness with visual or tactile stimulus	Must score	If patient attends to both sides: Score=0	Score=2	

CN indicates cranial nerve; LOC, level of consciousness; and NIHSS, National Institutes of Health Stroke Scale.
Adapted from Lyden.[33] Copyright © 2017 American Heart Association, Inc.

It is recommended that a stroke severity assessment be performed with a tool such as the National Institutes of Health Stroke Scale (NIHSS)[5] and that ongoing education and quality improvement (QI) initiatives are performed to maintain competency for accuracy and efficiency in performing this assessment. Nurses certified in the NIHSS may perform the initial assessment and track specific deficits during the decision to treat and after treatment if the patient is a thrombolytic candidate. The NIHSS has limitations in assessing posterior circulation and nondominant hemisphere strokes.[5] Techniques to assist in performing elements of the NIHSS examination are highlighted in Table 4.[33] In selected cases when the patient's presenting neurological deficits fall outside the NIHSS assessment or there is a concern that the patient may develop worsening symptoms not captured in the NIHSS, the stroke team may direct a more focused neurological examination for trending stroke severity.

The time line for the rapid evaluation of a patient with a suspected stroke to render a definitive or working diagnosis of AIS has had a continuously shrinking trajectory. Certification standards addressing laboratory results and imaging interpretation have traditionally been set at <45 minutes from patient arrival. This was coupled with the understanding that within the subsequent 15 minutes intravenous thrombolytics could be ordered, prepared, and administered within a 60-minute time window from patient

Table 5. Target: Stroke: AHA-Suggested Time Interval Goals

Action	30-min DTN time interval goal, min	45-min DTN time interval goal, min	60-min DTN time interval goal, min	90-min DTD time interval goal, min
Door to physician	≤2.5	≤5	≤10	≤5
Door to stroke team	≤5	≤10	≤15	≤10
Door to CT/MRI initiation	≤15	≤20	≤25	≤20
Door to CT/MRI interpretation	≤25	≤35	≤45	≤35
DTN	≤30	≤45	≤60	≤45
Door to neurointerventional team activation				≤40
Door to patient arrival in NIR suite				≤60
Door to puncture				≤75
DTD				≤90

AHA indicates American Heart Association; CT, computed tomography; DTD, door to device; DTN, door to needle; MRI, magnetic resonance imaging; and NIR, neurointerventional team/suite.

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arrival. The updated AHA recommendations and revised algorithms now reflect a tighter evaluation time line with a goal of having selected candidates treated with intravenous thrombolytics within a 30-minute time window (Table 5).

Drug/Device: AIS Treatment

In the modern reperfusion era, AIS treatment with tissue plasminogen activator (alteplase) within the first 3 hours of symptom onset, derived from the original National Institute of Neurological Disorders and Stroke alteplase trial[34] and trialist collaborative,[35] is the current standard of care[5] and has been approved by the US Food and Drug Administration since 1996.[36] Earlier administration correlates with a higher treatment effect. Alteplase also has become a standard of care for select patients within a 4.5-hour window of LKN.[37] To ensure the safe selection of patients, all centers should have care protocols derived from current promulgated clinical practice guidelines.

Systems should operate under the premise that eligible patients receive alteplase in the fastest achievable onset-to-treatment time.[5] In addition to a review of the inclusion and exclusion criteria (Table 1 in the Data Supplement), a risk/benefit discussion should occur between a stroke team member and either the patient or a legally authorized patient representative, with summary documentation of the discussion evident in the medical record. For each time window, the dose of alteplase is 0.9 mg/kg to a maximum of 90 mg over 60 minutes with an initial 10% of dose given as a bolus over 1 minute. Alteplase may be mixed by an ED nurse, designated stroke nurse, or pharmacist; this is preferential to a central pharmacy sending the drug via a "runner." A dual sign-off or verification of the dose can be performed and documented by 2 of the stroke response team members. It is a current standard to have a subsequent order for a normal saline flush. The nurse should administer the saline at the same rate to ensure that the patient receives the entire dose of alteplase and to prevent bolus dosing of the alteplase remaining in the tubing.[38] In the future, it is anticipated that clinical trial literature and practice guidelines will evolve to include the use of tenecteplase as a thrombolytic treatment for AIS. Recent evidence suggests that a dose of 0.25 mg/kg may be adequate. One advantage of tenecteplase is that the total dose is administered via intravenous push rather than an intravenous infusion.[39]

To facilitate shared decision making and informed consent (verbal or written), EDs should have relevant stroke education materials that can be provided to patients and families to complement discussions of the treatment decision and the anticipated next steps in care. If the patient is unable to consent or if a legally authorized patient representative is not available, it is reasonable to proceed with interventions that the stroke team believes to be the current standard of care and to perform procedures, if necessary, under the premise of emergency consent.[6]

The frequency of monitoring the patient after intravenous thrombolytic therapy is outlined in Table 2 in the Data Supplement and reflects the standards that were used in the 1995 National Institute of Neurological Disorders and Stroke trials and cited in the 2019 Ischemic Stroke Guidelines.[6] Recent studies have investigated timing of complications to understand the risk of deviating from the monitoring requirements of the original trial. The risk for complications after thrombolytic therapy is higher during the first several hours after alteplase administration; patients are typically cared for on units (critical care, stroke units, progressive or intermediate care units) that meet the care recommendations.[40] A protocol for responding to bleeding or other complications (ie, angioedema) should be included in the AIS policy (Table 3 in the Data Supplement).[6]

MT with stent retrieval devices has become a standard of care for eligible patients with LVO.[6,41] Patients with suspected LVOs, using a prehospital LVO scale or an initial NIHSS, or at the discretion of the stroke team evaluation, should have noninvasive neurovascular imaging as quickly as possible because they may be candidates

for MT. A CTA may be obtained before acquisition of serum creatinine levels in patients with no history of renal dysfunction, with current evidence also suggesting that the risk of acute kidney injury from contrast exposure in patients with chronic kidney disease is low.[42] For patients with relatively minor symptoms (ie, NIHSS score <6), it is still reasonable to acquire early hyperacute-phase vessel imaging because a proportion of these patients may have an LVO and subsequent clinical deterioration within several hours.[43] Imaging of the extracranial carotid and vertebral vasculature, in addition to the intracranial vessels, is reasonable and may yield information influencing procedural planning. It may also be reasonable to incorporate collateral flow assessments via multiphase CTA in the clinical decision-making process to determine MT eligibility in some treatment candidates.[6]

For select patients with LVO presenting within 6 hours of LKN, 6 clinical trials[37,41,43–46] demonstrated an unequivocal treatment effect using predominantly stent retrieval devices. These trials underlie the 2019 AHA/American Stroke Association clinical guidelines Level IA recommendation for this procedure in patients who have a prestroke modified Rankin Scale score of 0 to 1, are >18 years of age, have an NIHSS score ≥6, have an ASPECTS (Alberta Stroke Program Early CT Score) of ≥6, have a causative occlusion in the internal carotid or proximal middle cerebral artery segment (M1), and could have skin puncture within 6 hours of stroke onset.[5] A secondary analysis by the HERMES group[44] (Highly Effective Reperfusion Evaluated in Multiple Endovascular Stroke Trials) of 5 of the trials demonstrated a time-sensitive treatment effect with a less favorable degree of disability for every hour of delay to reperfusion. Of MT candidates also eligible for thrombolysis, alteplase is still administered as a first-line therapy if the patient meets alteplase eligibility criteria.[5]

For patients with LVO presenting in the extended 6- to 24-hour window, the acquisition of penumbral imaging (CT perfusion, diffusion-weighted magnetic resonance imaging with or without magnetic resonance imaging perfusion) is a prerequisite for selecting patients for endovascular thrombectomy. Patients were included if they had an LVO of the cervical[47] or intracranial[47,48] internal carotid artery and proximal[47] or first segment[48] of the middle cerebral artery. Criteria for the clinical deficit/infarct volume mismatch used in the DAWN (Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention With Trevo) and DEFUSE 3 (Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke) randomized controlled trials are listed in Table 4 in the Data Supplement. CT perfusion and magnetic resonance imaging diffusion and perfusion scans were calculated with use of the automated postprocessing software systems. It is possible in the future that promulgated guidelines could support the use of similar advanced imaging techniques (ie, CT perfusion or magnetic resonance imaging sequences looking for diffusion/fluid-attenuated inversion recovery mismatch) to select patients eligible for thrombolysis in the extended time window.

Nurses that care for an MT candidate focus on the transfer, coordination, and handoff of the patient to the staff in the MT procedure suite. Time goals from arrival to the procedure suite have been established for patients initially arriving to the hospital and for patients being transferred from a sending hospital. It is reasonable to aim for a 90-minute time window (ED arrival to skin puncture) and a 60-minute time window (ED arrival to skin puncture) for patients transferred from a sending hospital.[49,50] In some systems, a select group of out-of-hospital transfers will go directly to the thrombectomy suite, bypassing the ED. It is advisable to establish criteria for considering bypassing the ED in the event that there is a change in the patient's clinical status that would warrant additional preprocedure management. For cases referred from the ED, a handoff report ideally includes key elements of the patient's care in the ED and optimizes communication between the 2 teams involved in the acute care phase. Supportive care for all patients with ischemia undergoing medical or interventional reperfusion procedures includes providing supplemental oxygen to maintain an oxygen saturation >94%, avoiding hypotension and hypovolemia, which decreases systemic perfusion, avoiding hyperthermia, and, for patients receiving alteplase, keeping a systolic blood pressure <180 mm Hg and diastolic blood pressure <105 mm Hg.[6]

Telestroke

Telestroke refers to practicing vascular neurology in a location separate from the patient via audio-video communications.[51,52] With the increase in the aging population and paucity of stroke-experienced neurologists, limitations to access have made telestroke an integral part of the continuum of stroke care.[53] Telestroke can facilitate more equitable care by providing expedient, efficient, and accurate evaluations, which are critical to the outcomes of patients with stroke. Providing access for all patients increases the probability of further lowering stroke morbidity and mortality.[52] Studies have shown that the use of telestroke increased rates of alteplase administration in shorter door-to-needle time and risks similar to in-person neurology care.[53]

Early activation in stroke care begins in the prehospital setting. The nurse may act as the initial point of contact alerting the teleneurologist to an incoming patient with stroke symptoms by EMS or through triage by private vehicle. This early communication helps mitigate any delays that may be caused by failure of internet service or equipment integrity. It also reinforces the role of the teleneurologist as an integral member of the stroke response team and affords them early access to the patient's history and presenting symptoms.

Table 6. AHA Prehospital Management Recommendations

Assess airway, breathing, circulation; do not treat high blood pressure unless recommended
Implement cardiac monitoring
Maintain oxygen saturation >94%
Assess blood glucose and treat if <60 mg/dL
Do not administer excessive intravenous fluids or solutions containing glucose
Do not give any fluids or medication by mouth
Establish intravenous access, two 18 gauge if possible
Determine LKN
Document medical history and medication use
Obtain family/friend/bystander phone numbers
Provide rapid transport to the most appropriate hospital capable of stroke emergency treatment

AHA indicates American Heart Association; and LKN, last known normal.
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Communication

The role of the ED nurse in telestroke is critical in promoting a therapeutic patient-physician interaction. Nursing competencies in telehealth include the ability to combine clinical experience with telehealth, coaching skills, and the ability to present clinical information with a supportive attitude that places a patient at ease.[54] The nurse often acts as a conduit between the patient and the teleneurologist to facilitate obtaining a history, completing a comprehensive neurological assessment, including the NIHSS, and implementing treatment recommendations under the teleneurologist's guidance. In essence, the ED nurse anticipates the steps during a telestroke consultation, which allows an expedited evaluation despite the added technology.

To improve the patient's comfort and openness to the video exchange, the nurse should explain to the patient that a neurologist will be evaluating the patient in video format. Members of the stroke response team should be mindful that the audio of most telemedicine platforms picks up extraneous sounds in the room. Therefore, having other conversations while the physician is speaking to the patient should be discouraged. The teleneurologist has a limited patient view and may want to zoom in on specific features of the examination. Maintaining awareness of the physical environment of the room and body positioning of both the patient and nurse in relationship to the camera is important throughout the assessment. If the nurse must leave the encounter, the nurse should notify the teleneurologist.

Assisting With the Neurological Assessment

The neurological assessment together with the history are critical components in making an ischemic stroke diagnosis. The nurse should be prepared to assist in communicating key elements of the patient's medical history, including the patient's LKN time, historic and current vital signs, allergies, and their medication list, because the teleneurologist may not have access to the medical record.

Table 7. ED Nursing Evaluation

Perform a quick assessment to ensure that airway, breathing, and circulation are stabilized
Obtain blood pressure and blood glucose
Confirm time of stroke symptom onset
Confirm medical and current medical history
Complete a rapid neurological examination such as the NIHSS
Assist in obtaining a rapid initial noncontrast CAT scan
Place 2 intravenous lines
Collect laboratory studies

CAT indicates computerized axial tomography; ED, emergency department; and NIHSS, National Institutes of Health Stroke Scale.
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During the telestroke consultation, the family member is often brought into the evaluation to obtain additional history and to help make treatment decisions. In addition, the data collected by EMS should be available and communicated between the nurse and the teleneurologist.

Numerous studies support telestroke evaluations as being as robust as the bedside neurological examination for the diagnosis of acute ischemic stroke.[51,52] The evaluation begins by observing the patient's movements and disposition, making a video examination amenable to teleneurology. The nurse should communicate objective information about the subjective aspects of the physical examination. It is important to note that the teleneurologist may not perform the elements of the examination in the same systematic way that the nurse is accustomed to in time-sensitive situations (Table 4).

Disposition: Transition of Care

The literature defines disposition as the transfer of patients out of the ED to an intensive care unit or stroke unit. Transitions of care incorporate an expansive range of services occurring between health care practitioners and settings designed to ensure continuity and coordination to promote safe and timely transfer of patients and to avoid unsatisfactory outcomes. Transition is a time of greatest vulnerability, creating nursing opportunities to improve quality of care and to reduce stroke risk.[55]

The continuum of stroke care includes the prehospital, emergency, acute, postacute, and long-term management. Nursing interventions during transitional periods can successfully improve stroke outcomes. The first transition occurs at symptom onset, recognition of symptoms, and activation of EMS. Key nursing components of prehospital care and transitional role responsibilities during the acute phase are summarized in the ED Code Stroke Pathway (Figure)[31] and Table 6.

During the emergency phase of care, the nurse continues critical assessments (Table 7) started in the field by EMS.[56] Triage, assessments, imaging, and treatment are vital to preserving brain tissue and improving outcomes.

Table 8. Suggested Prehospital and Emergent Stroke Care Quality Measures

Measurement	Description	Example of success
Time to dispatch	Track median time from 9-1-1 call to EMS dispatch	Use of structured protocol-driven caller interrogation to gain necessary data to activate calls more accurately; EMS dispatcher education and written resources on recognizing stroke signs and symptoms as reported by callers; stroke system protocols that dispatch EMS responders with the most rapid emergency response time limits and goals as other acute events.
EMS on scene time	Percent of time ≤15 min from arrival on scene to departure for stroke-capable facility	Rapid field assessment by EMS; EMS measuring and decreasing scene times; use of stroke screening and stroke severity assessment tool by EMS; development of triage protocols at the local, state, and regional levels; percent of stroke prenotification to facility; transparency in sharing treatment and patient outcome data between EMS and stroke-capable health care facility; EMS education on importance of prearrival notification for early mobilization of stroke resources and cerebrovascular disease and impact of time on patient outcomes.
LKN documented	Percent of patients with documented LKN by EMS	
BG measurement	Percent of patients with documented BG measurement	
Stroke screening tool used	Percent of patients with documented stroke screening score	
Severity stroke screening tool used (LVO)	Percent of patients with documented stroke severity screening score	
Prenotification	Percent of patients with early EMS prenotification of potential stroke to receiving hospital	
Arrival mode	Percent of patients who arrive by EMS vs personal vehicle Compare EMS arrival rates with community stroke awareness events during the same time periods	Rapid triage protocols for patients arriving by EMS and personal vehicle have improved treatment times; community education targeting vulnerable populations; patients with a positive stroke screen or who are strongly suspected to have a stroke should be transported rapidly to the closest stroke-capable health care facility.
Telestroke consult times	Track median time to telestroke consult notification; phone response; video-consult initiation; and consult completion Percent of patients who receive a consult within 20 min of request	Facility early activation protocols for both EMS and private vehicle arrivals; regional systems of care.
Patient and provider satisfaction with telestroke consult	Track patient and provider satisfaction with use of telestroke consult process	The nurse educates the patient about telestroke physician, arranges room, and prepares to facilitate the physician-patient interaction.
Telestroke decision-making times	Track median time to telestroke treatment decision	Standardize checklist of key items to communicate: EMS report, vital signs, medication list, allergies, and LKN.
Telestroke technical failures	Track percent of technical failures and impact on care	Integration of information technology resources in planning; sharing of data between telestroke program and providers.
Patient transfer	Track median time to transfer patients between organizations	Transfer policies; QI activities; integration of local EMS and systems of care.
Door to CT/MRI initiation	Percent of patients who receive brain imaging ≤15, 20, and 25 min of arrival	Patients who go straight to CT on hospital arrival via EMS have decreased door-to-imaging times.
Door to CT/MRI interpretation	Percent of patients who receive imaging results ≤25, 35, and 45 min of arrival	Remote review of imaging for treatment decisions.
Door to ED provider evaluation	Percent of patients seen by ED provider in ≤2.5, 5, and 10 min	Stroke pathways delegating duties according to role; use of a stroke activation tracking tool and feedback improves provider response times (Figure 1,[31] roles of stroke team/process).
Door to stroke team or neurologist evaluation	Percent of patients seen by stroke team in ≤5, 10, and 15 min	Facilitate early activation protocols for both EMS and private vehicle arrivals.
NIHSS performed	Percent of patients who receive an initial NIHSS before initiation of thrombolysis	Use of templated admission notes requiring documentation of the NIHSS score.
Door to pertinent laboratory values	Rapid glucose results and when indicated percent of patients who require coagulation results within 30 min of arrival	Use of EMS glucose results; laboratory draws by EMS; use of point-of-care testing decreases laboratory result times.
Time to intravenous thrombolysis	Percent of patients receiving thrombolysis therapy in ≤30, 45, and 60 min	Nurse-led triage team, nurse practitioners assigned to facilitate assessment, and workup and delivery of thrombolytic therapy have led to decrease door-to-needle times.
Intravenous thrombolysis, treat by 3 or 4.5 h	For 3 h: Percent of patients who arrive to the hospital within 2 h of LKN and receive thrombolysis within 3 h For 4.5 h: Percent of patients who arrive to the hospital within 3.5 h of LKN and receive thrombolysis within 4.5 h	Early drug preparation; pharmacy in the ED; RN preparation; drug administration in CT scanner.
Intravenous thrombolysis complications	Percent bleeding complications associated with thrombolysis therapy	BP management protocols; angioedema protocol; anticoagulation reversal protocol.
Door to NIR activation	Median time to NIR team notification ≤40 min	Early notification of NIR team of potential patient; effective prehospital procedures to identify patients who have a strong probability of LVO to facilitate rapid transport; LVO screening in the ED.

(*Continued*)

Table 8. Continued

Measurement	Description	Example of success
Door to patient arrival in NIR suite	Percent of patients arrival to NIR ≤60 min (transfers from outside facilities)	NIR suite preparation, including equipment/device arrangement and placement; NIR nurse or stroke nurse facilitating transport of patient from ED to NIR.
Door to puncture	Percent of patients with puncture time ≤75 min	Delegation of duties according to role; activation and tracking tools for QI; designated team positions in room to enhance workflow.
Door to device	Percent of device deployment ≤90 min (arrivals at NIR facility)	Cross-training of nurse roles, ie, neuro-ICU RN covering NIR; surgical RN or technician preparing room.

BG indicates blood glucose; BP, blood pressure; CT, computed tomography; ED, emergency department; EMS, emergency medical services; ICU, intensive care unit; LKN, last known normal; LVO, large vessel occlusion; MRI, magnetic resonance imaging; MT, mechanical thrombectomy; NIHSS, National Institutes of Health Stroke Scale; NIR, neurointerventional team/suite; RN, registered nurse; and QI, quality improvement.

Suggested time interval goals, reflected in Table 5, by the AHA guide organizations in meeting benchmarks and improving quality of stroke care and patient outcomes.[32]

A well-designed electronic health record platform facilitates coordination of care by sharing up-to-date information, including diagnostic and other patient-specific information. Electronic health records decrease fragmentation of care through improved communication of patient information during transitions and communication of early care delivery that may be viewed throughout the hospital stay and even after discharge when systems are electronically linked. These same electronic health records are capable of electronically identifying patients with strokes, automating data collection, and electronically reporting quality metrics used to improve care delivery for patients with stroke.[57]

QUALITY IMPROVEMENT

Quality and safety are important factors in the delivery of stroke care. Nurses not only deliver care but improve it by harnessing the expertise of the interdisciplinary team while focusing on efficiencies of workflows and quality of care. Empowering nurses to lead change produces a sense of ownership in how they deliver care and allows the team to experience a sense of accomplishment when a meaningful change occurs.[58]

QI provides a systematic method to use data collected to drive improvements. Data and performance measures drive QI and set a standard for comparison. Nurses are often involved in stroke data collection and analysis. Collecting data creates the capability to use the data to improve delivery of care to patients with stroke. Examples of how data drive QI in acute stroke care include (1) collecting data at different time points in the evaluation and being able to reduce treatment times,[5,32] (2) monitoring for alteplase complications and developing an improved postprocedure checklist, (3) collecting data on atypical stroke presentations and incorporating those elements into a triage worksheet,[27] and (4) using data to evaluate adherence to documentation requirements and creating nurse reminders or to enhance workflow in the electronic health record.[57] Certified stroke centers incorporate many of the aforementioned QI projects as part of their larger performance improvement plans. Shared data and successful improvement projects support the efforts that lead to successful stroke systems of care.

Nurses may be at the forefront in designing the structured steps in QI that lead to measurable improvement in patient health and health care services. It is essential that nursing leaders in stroke care (ie, stroke managers, coordinators, and directors) receive training in QI methodologies. In addition, managing complexity, leading change, and ensuring that change is sustained are necessary skills in the rapidly evolving and complex nature of stroke care.[58]

The AHA Get With The Guidelines program and the Paul Coverdell National Acute Stroke Registry are national databases aimed at providing data to guide performance improvement that serve as a source of scientific inquiry with the ultimate goal of improving stroke care and outcomes.[59] In addition, the National Quality Forum and the Centers for Medicare & Medicaid Services endorse specific stroke measures developed by the AHA in conjunction with The Joint Commission for hospital reporting and comparison as identified through Target: Stroke (Table 5).[32] Performance measures relevant to the prehospital and emergent phase of stroke care are described in Table 8.

Stroke quality measures continue to evolve as treatment advances and systems of care respond to patient needs. Vigilance in maintaining awareness of QI initiatives that will inform practice allows stroke teams to identify areas of improvement in structure and process that may affect the delivery of stroke care. Implementation of strategies can be tested for change and then measured to ensure that the intervention made an improvement and not just a change before implementation across stroke programs.

Nurses play a central role in improving statewide stroke systems, be it forging networks with other centers, leading grassroot efforts, or serving on a stroke task force or state stroke coordinators committee. The writers challenge nurses to take an active role in local, state, and regional health care platforms that target initiatives to address economic, racial, and sex disparities affecting access to emergency stroke care.

The writers acknowledge the impact that the emerging infectious disease COVID-19 has had on managing stroke care over the last 12 months. EMS, EDs, endovascular, and inpatient teams are striving to provide

timely stroke care and intervention considering safety to both the patient and the health care team. The temporary guidance published by the AHA/American Stroke Association Stroke Council Leadership[60] provides recommendations while we await further understanding of the disease and its impact on care delivery processes and patient outcomes. Further nursing research into the care and ongoing monitoring of the patient with ischemic stroke during this time is critical in developing recommendations and guiding future practice.

ARTICLE INFORMATION

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

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*Modest.

†Significant.

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