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on behalf of the American Heart Association Advocacy Coordinating Committee

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on behalf of the American Heart Association Advocacy Coordinating Committee

In the United States and other parts of the world, various cities, states, and regions are developing multitiered systems for the care of patients with acute stroke. These systems often involve a range of healthcare components supported by various rules and regulations. The present policy statement will put forth concepts and elements for stroke systems of care that are intended to optimize patient care and management processes and improve patient outcomes, are practical to implement, and are supported by existing clinical data or expert consensus opinion. We will also make policy recommendations for the key elements of a stroke system of care.

The public health implications of stroke care in the United States and worldwide are profound. Stroke is currently the fourth-leading cause of death in the United States and a major cause of long-term disability. Advancing age is a major risk factor for stroke, and the demographics of the US population and elsewhere reflect a continued growth of the aging population, with a resulting increase in the absolute incidence and prevalence of stroke.¹ Improved stroke systems of care can ensure proper treatment of these patients and a reduction in death and disability. This is consistent with current American Heart Association and Centers for Disease Control and Prevention Healthy People 2020 public health goals and initiatives.²

There are several new care paradigms and technologies that are emerging as important elements of a stroke system of care.

These include the development and proliferation of various levels of stroke centers; the expanded use of telemedicine technologies; advanced medical, endovascular, and surgical interventions; and comprehensive rehabilitation strategies and programs. Prehospital care and triage and the efficient transfer of patients between hospitals are also key components of stroke systems.

The present statement will not discuss the issue of prevention of the development of stroke risk factors (so-called primordial prevention) or the identification and treatment of established stroke risk factors (primary prevention). Recent guidelines and recommendations address these issues.³ The importance of such efforts and programs to prevent a stroke before it occurs are clear. Many government agencies, healthcare organizations, and providers are addressing these vital preventive strategies. Our focus will begin with recognition of initial stroke symptoms and continue through activation of emergency medical services (EMS), hospital care, discharge, and rehabilitation. Secondary stroke prevention and the prevention of subsequent cardiovascular events will also be addressed.

A fully functional stroke system of care that reduces stroke-related deaths by just 2% to 3% annually would translate into 20000 fewer deaths in the United States alone and ≈400000 fewer deaths worldwide. Poststroke disability would also be reduced, which would improve the quality of life, result in the more efficient use of healthcare resources, and reduce the

*Drs Higashida and Alberts contributed equally to the statement.

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financial burden on patients and their families, third-party payers, and governments.

Below are outlined some of the key concepts and components of a modern stroke system of care in the United States. These elements will vary in different parts of the country (and the world); however, the general approach and principles should be useful to many healthcare professionals and others involved in such a system.

Interactions Within Stroke Systems of Care

Transportation of Patients From Home to Hospital via EMS/Ambulance

The time from symptom onset to arrival at an emergency department (ED) is the greatest source of delay and a frequent cause of ineligibility for acute reperfusion therapies.^{4,5} More specifically, a lack of patient and public awareness of stroke signs and symptoms, the urgency of immediate care, and the need to call 9–1–1 for EMS activation are the main causes for delayed patient presentation to an ED.^{6–10} An intensive program to improve public education about stroke symptoms and the need for rapid care can significantly reduce these time delays and increase the number or percentage of patients who may be eligible for acute therapies.^{11–13} Once these efforts end, presentation time delays tend to regress to their baseline levels. To achieve a continual benefit, such programs must be continued long-term with rotating or new messages.^{12–14}

Another important aspect of prehospital care is the designation and consistent use of a standardized assessment scale. Several studies have found that the FAST score (facial droop, arm drift, speech problems test) and the LAPSS (Los Angeles Prehospital Stroke Screen) are both easy to learn and use, and both provide reliable and consistent data. Each tool has been used extensively by various EMS systems and personnel throughout the country.^{10,15}

Several studies have shown that prehospital notification by EMS reduces door-to-imaging, door-to-needle, and intrahospital transport times in patients with acute stroke.^{16,17} Although most of these studies focused on treatment with intravenous tissue-type plasminogen activator (tPA) for ischemic stroke, it might be expected that prehospital notification could also improve evaluation and treatment times for patients with all types of stroke. Thus, this paradigm is strongly supported and encouraged.

A significant percentage of patients (up to 50% in some studies) with an acute or subacute stroke present at a hospital via private car, taxi, or another mode of transportation (other than an ambulance). In this case, the ED triage component will be of key importance, with an overall paradigm similar to any ED evaluation of a suspected stroke patient as described in “Triage and Routing Considerations.” If the patient’s initial assessment and imaging define the type and severity of stroke, then transfer to an appropriate level of care (ie, primary stroke center [PSC] or comprehensive stroke center [CSC]) should be performed.

Triage and Routing Considerations

There are important issues to consider when determining the transport destination of a known or suspected stroke patient, including patient preference, regional hospitals’ stroke capabilities or capacity, transport distances, transportation options, time from symptom onset, and stroke severity. Although

prehospital care providers must consider the patient’s hospital preference and where they have received prior care, EMS providers must understand the capabilities of the destination hospital with regard to providing definitive stroke care. Hospitals with high stroke volumes, those with stroke units, and certified stroke centers have better stroke outcomes than hospitals without this expertise, experience, and resources.^{18–22} This observation has been made in separate studies evaluating patients with ischemic and hemorrhagic stroke. The various types of stroke centers are discussed below in more detail.

There is also concern that the initial presentation of a patient at a hospital that is not appropriately equipped to provide emergent care can result in time delays that may exclude a patient from some acute therapies once the patient finally arrives at a certified stroke center.^{23–27} The secondary transfer of a patient to a PSC or CSC to initiate treatment can greatly increase the delay from symptom onset to acute therapy.²⁸

It is important that prehospital care providers have a predetermined plan with regard to the triage of acute stroke patients. In formulating this regional plan, input should be solicited from key stakeholders within the local stroke systems of care.²⁸ By having an established regional triage plan, prehospital care personnel are not placed in the situation of making potentially complicated triage decisions while simultaneously providing critical care to a stroke patient in the field.

Specific triage protocols within a region must consider several factors, such as time from onset (or last known normal), specific patient characteristics, distances to various hospitals, and the capabilities of regional hospitals. This high degree of complexity can overwhelm EMS personnel and make it difficult for them to make a timely and accurate triage decision, especially when acute stroke represents a small percentage of the total EMS dispatched calls. Issues such as defining time of onset of stroke can be challenging to obtain in the prehospital setting and difficult to convey in a simple and actionable manner, and many registries and the National Institute of Neurological Diseases and Stroke Common Data Elements Project have focused on ascertaining both the time last seen well and the time symptoms were first discovered to ensure accurate data capture and decision making by medical personnel. Solutions must be appropriate for the region and effective at guiding appropriate triage without being burdensome.²⁸

In some rural settings, EMS might be staffed predominantly by volunteer personnel. The training and expertise of these personnel are likely to vary based on local and regional factors, patient volumes, and so on. However, because of the importance of stroke as a major public health issue, combined with the need for emergent care of such patients, we encourage regional and state government EMS personnel to make such educational and training efforts a high priority.

There are other aspects of field triage of suspected stroke patients that are complex and problematic. It is not currently possible for EMS personnel (with or without medical guidance) to accurately diagnose and distinguish ischemic from hemorrhagic stroke. The ability of EMS personnel to differentiate anterior versus posterior circulation strokes in the field is also a significant challenge. Although important indicators of stroke severity, conditions other than stroke can cause acute focal neurologic deficits and impaired consciousness. With these limitations in

mind, some general guiding principles (Figure 1) are suggested to assist in organizing triage and diversion protocols.

During the triage process, it is critically important for EMS personnel to determine when the patient was last known to be neurologically normal (or at their baseline neurological status). This provides guidance about which, if any, interventional time windows and therapies may be appropriate, thereby further influencing patient transportation and potential destinations.²⁸ For example, a patient with mild stroke symptoms that were present for 4 days is likely not a candidate for most acute emergent therapies.

It is reasonable to start with initial triage considerations based on time from last known well. For those patients within 6 to 8 hours from symptom onset, if only 1 hospital within a region is an acute stroke-ready hospital (ASRH), a PSC, or a CSC, this should be the destination of choice. (The different types of stroke centers are described in detail in “Levels and Types of Hospital Care.”) If multiple stroke-capable hospitals are within a similar driving distance, then patient preference, stroke severity, and other patient and regional stroke hospital characteristics may influence EMS triage decisions within the 6- to 8-hour time window. These decisions are often controlled by local rules and regulations.

Unless there are other compelling mitigating circumstances, EMS should not bypass the closest facility to go to a higher-level facility if such a diversion would add more than 15 to 20 minutes to the transportation time. This is based in part on the 15- to 20-minute time window for arrival of members of an acute stroke team, is standard for most general EMS diversion protocols, and has been widely accepted for the past 10 to 15 years for stroke^{29,30} to guide diversion protocols for other types of patients who require acute care. These time windows might be modified for very rural areas and in case of other significant geographic challenges. This might further change as new assessment capabilities and treatments evolve.

When there are several PSCs and CSCs all within roughly equal distances and times for patient transportation, in general we recommend transportation to the highest-level facility, because (1) the type of stroke (ischemic, hemorrhagic) is unknown by EMS personnel, and (2) even if the patient appears stable, the patient may worsen in the upcoming minutes, hours, or days. This paradigm will be adjusted on the basis of the overall particulars of each patient and the medical judgment of EMS medical control officials.

It is not the intention of the present policy statement to imply that every acute stroke patient should bypass a nearby PSC and be routed to a CSC. Indeed, with a relatively small number of CSCs (perhaps 100–250) anticipated and ≈1000 PSCs (currently certified by The Joint Commission) currently receiving and successfully treating many acute patients, the CSCs would likely be overrun by such a paradigm. A combination of field triage and high-level medical guidance of EMS will be needed to ensure a fair and equitable routing paradigm. It is recommended that a stroke system prospectively track the routing of patients and the impact on hospital volumes and possible overloading of specific hospitals.

This time window does not translate into a transportation distance because of factors such as traffic, geography, and weather. The above approach ensures that patients would reach a hospital (ASRH, PSC, or CSC) relatively rapidly, which would hasten an initial examination, imaging, stabilization, and emergent therapy before further transportation takes place.

There are preliminary studies using real-time telemedicine links in EMS vehicles to allow medical personnel at a PSC or CSC to evaluate the patient and assist in making emergent triage decisions.³¹ As more data are gathered about the efficacy and accuracy of such technologies, this may become an important tool for some systems, especially in rural locations.

It is important for EMS personnel to be aware of the role air medical transport can play in the transfer of patients to an appropriate hospital facility. Similar to the care of trauma patients, air medical transport may be needed to transfer a stroke patient to a geographically distant hospital that is capable of providing an advanced level of stroke care.²⁸ Studies show the utility of air medical transportation for patients with acute strokes.^{32,33}

Regardless of the triage protocol used, ongoing quality assessment should be conducted to evaluate protocol adherence and acceptability. This will ensure that patients are transported to the most appropriate facility and will identify the need for triage protocol modifications. It is the responsibility of all regional stakeholders to provide feedback and work toward optimizing the prehospital phase of stroke care.

Policy Recommendations

1. Public health leaders along with medical professionals and others should design and implement public

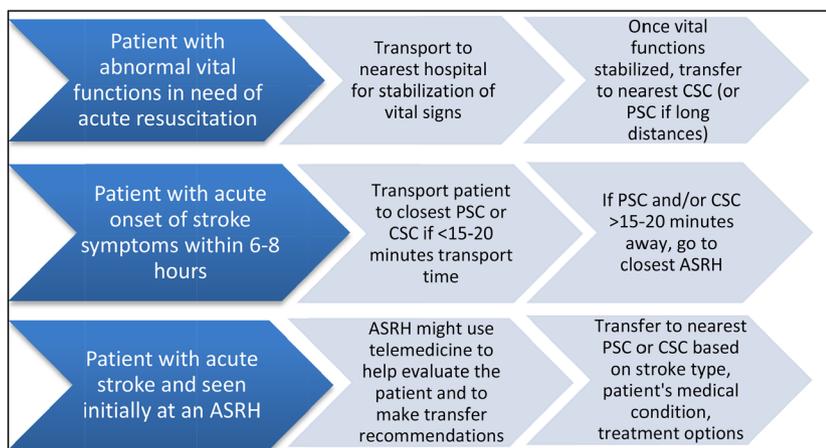


Figure 1. Guiding principles for field triage of patients with suspected acute stroke. ASRH indicates acute stroke-ready hospital; CSC, comprehensive stroke center; and PSC, primary stroke center.

education programs focused on stroke symptoms and the need to seek emergency care (by calling 9–1–1) in a rapid manner. These programs should be repetitive and designed to reach diverse populations.

a. EMS leaders in coordination with local, regional, and state agencies and in consultation with medical authorities and local experts should develop triage paradigms and protocols that ensure that all patients with a known or suspected stroke are rapidly identified and assessed by use of a validated and standardized instrument for stroke screening, such as the FAST (face, arm, speech test) scale, LAPSS, or the Cincinnati Prehospital Stroke Scale (CPSS).³⁴

2. Unless there are compelling mitigating circumstances, when there are several acceptable hospitals (ASRH, PSC, CSC) in a well-defined geographic region, extra transportation times to reach another facility should be limited to no more than 15 to 20 minutes. When several hospital options exist, EMS should seek care at the facility capable of offering the highest level of stroke care. This is based in part on concerns that although a patient may initially appear to be appropriate for PSC-level care, they might deteriorate and need transfer to a CSC, which would lead to further treatment delays.

a. Protocols that include prehospital EMS notification that a stroke patient is en route should be used routinely.

Levels and Types of Hospital Care

A stroke system of care encompasses 4 different types of acute care facilities, each with its own characteristics, goals, roles, strengths, and limitations. These are listed in Table 1.

The ASRH is typically a smaller facility in an isolated suburban, rural, or other location and is unable to provide the full level of care available at a PSC or CSC. The roles of an ASRH are to stabilize the patient, provide specific acute stroke care therapies, and arrange transportation of patients to the nearest PSC or CSC facility as determined by the patient's clinical

status and further treatment indications. It is anticipated that within a rural region with 5 to 10 small hospitals, perhaps 2 to 3 would become ASRHs. EMS would preferentially triage stroke patients to the nearest ASRH in these communities.

In many cases, an ASRH would establish a telemedicine link to a PSC or CSC or use other validated methods to obtain clinical stroke expertise, interpret brain imaging, initiate thrombolysis if indicated, address issues such as active bleeding or high intracranial pressures, and arrange transfer to a more advanced facility as appropriate. The ASRH should have prearranged written transfer protocols, policies, and arrangements with 1 or more PSCs or CSCs to expedite such transfers. Such arrangements should be well established so that patient transfers during "off hours" proceed efficiently. Ideally, these would be the same hospitals that provide remote consultation support.

Revised guidelines for PSCs have been published recently.³⁰ These hospitals can care for the majority of stroke patients with typical ischemic strokes who do not require endovascular therapy, neurosurgical interventions, or intensive care unit (ICU)/neurocritical care unit-level care or who have multisystem disease. Some PSCs do offer ICU-level care. There are ≈1000 PSCs certified by The Joint Commission and perhaps 100 or more PSCs certified by state departments of health or other accreditation programs or that are self-certified.

Patients cared for at a PSC have lower death rates and overall improved outcomes compared with those who receive care at a general hospital or nondesignated stroke center.^{22,37} The use of treatments such as intravenous tPA is more frequent at PSCs, and the longer a hospital is certified as a PSC, the more likely it is to administer intravenous tPA.^{37,38} However, the effectiveness of PSCs is not dependent nor focused solely on the use of intravenous tPA. Several other elements of PSCs improve the care and outcomes of the >95% of patients who are not treated with intravenous tPA. Stroke units are another major component of PSCs that have been proven to improve care and outcomes. Other care elements such as following various guidelines are also key factors in improving care and outcomes. The improved outcomes at a PSC have been shown

Table 1. Some Characteristics of Typical Acute Inpatient Stroke Care Facilities

Characteristics	Hospital Type			
	Non-Stroke Center	ASRH	PSC	CSC
Typical bed count	20–50	30–100	100–400	400–1500
Annual stroke admissions	10–50	25–50	50–300	>300
Rapid neuroimaging 24/7*	No	Performed and read within 45 min of order	Performed and read within 45 min of order	Performed and read within 45 min of order
IV tPA capability 24/7	No	60-min door-to-needle time	60-min door-to-needle time	60-min door-to-needle time
Acute stroke team available	No	At bedside within 15 min	At bedside within 15 min	At bedside within 15 min
Stroke unit	No	No†	Yes	Yes
Neurocritical care unit	No	No	No	Yes§
Access to neurosurgical services	No	Yes, within 3 h or by transfer‡	Yes, within 2 h, in-house or by transfer	Yes, 24/7 coverage and call schedule

ASRH indicates acute stroke-ready hospital; CSC, comprehensive stroke center; IV, intravenous; PSC, primary stroke center; tPA, tissue-type plasminogen activator; and 24/7, 24 hours per day, 7 days per week.

*24/7 Neurological expertise available through telemedicine, on site, or a combination.

†Some ASRHs may have the necessary resources on site or via telemedicine to support a stroke unit.

‡This may vary based on geographic and other considerations.

§Or a defined neurocritical care service operating within the context of a medical or surgical intensive care unit.

in both US and international studies, although the design and elements of PSCs differ in the United States compared with European models. The formation of PSCs has expanded to include Europe, Asia, and Australia.^{22,36}

The CSC is intended to care for the most complex and challenging types of stroke patients, including those with large ischemic strokes, all types of hemorrhagic strokes, or multistyle involvement, as well as those who require surgical or endovascular interventions and ICU-level care. A typical CSC has many characteristics of tertiary care medical centers in the United States. There are perhaps 100 to 250 hospitals in the United States that could currently meet the major requirements of a CSC. The Joint Commission began a formal certification program for CSCs in September 2012.

Some of the specialized interventions at a CSC include the use of endovascular techniques to treat ischemic and hemorrhagic strokes; the ability to perform carotid endarterectomy, carotid stenting, and hemicraniectomy; the presence of an ICU or neurological ICU staffed by intensivists; and the ability to perform advanced neuroimaging techniques, including magnetic resonance imaging and angiography, computed tomography angiography, transcranial Doppler studies, and digital subtraction angiography, with related personnel for diagnosis and therapy. Many if not all of the elements of a CSC must be available on a 24/7 basis (24 hours per day, 7 days per week), which is one distinguishing characteristic between it and a PSC. (More details of the certification criteria can be found on The Joint Commission's Web site, <http://www.jointcommission.org>). Many of the personnel and infrastructure at a CSC improve outcomes, and a study from Finland found that patients cared for at a CSC had improved outcomes (reduced mortality, more likely to be discharged to home) compared with those cared for in a general hospital.^{20,39,40} A comparison between CSC and PSC care and outcomes is problematic because of the different populations seen at each type of facility.

The regionalization of acute stroke care is a reality in many parts of the United States and other countries. Within a region, it is envisioned that there would be a variety of stroke facilities, largely determined by the stroke population (numbers and distribution), geographic factors, and regional resources. This regionalization of care will better coordinate resources such as EMS, stroke centers, and telemedicine. A key goal of a stroke system of care is to ensure that all stroke patients are rapidly identified, transported, or transferred in a timely fashion to a hospital that can provide the most appropriate level of care for the particular clinical situation.

Hospitals in a stroke system of care should be encouraged to track the quality of their care through the use of national registries and make these data available to the public and other providers. Hospitals that cannot meet national benchmarks for adherence to evidence-based guidelines should be encouraged to transfer their stroke cases to a nearby appropriate facility with a demonstrated ability to do so. Although many factors impact such decision making, in general it is suggested that the vast majority of patients with an acute stroke should be cared for at a PSC or CSC, regardless of where and how they enter into the healthcare system.

Policy Recommendation

- 1. Healthcare authorities, medical leaders, and government agencies should support the formation, operations, and certification of stroke centers as one proven means to improve patient care and outcomes.** These stroke centers should publicly report their performance and outcomes.

Interactions Between Medical Staff at a Stroke Center

Optimal stroke care involves a well-coordinated team that incorporates and integrates multiple specialties and disciplines (Table 2). Existing recommendations for PSCs and CSCs³⁹ delineate the many different types of medical specialists and providers that are essential, but there is little existing literature on how these healthcare professionals should be organized and interact within the context of a stroke center.

What makes the situation even more complicated is the fact that hospital services are often organized into vertically oriented departmental "silos," such as neurology, neurosurgery, diagnostic radiology, interventional neuroradiology/endovascular neurosurgery, emergency medicine, and nursing. Lines of authority are often well established within departments, but coordinated efforts between services and departments are less common and can be difficult to organize and maintain. Team building and integration therefore

Table 2. Specialties and Disciplines Typically Involved in Stroke Care*

Case management
Emergency medicine
EMS
Hospital administration
Hospitalists and neurohospitalists
Internal medicine/cardiology
Laboratory
Midlevel providers (nurse practitioners and physician assistants)
Neurocritical care
Neuroendovascular
Neurology/vascular neurology
Neuroradiology
Neurosurgery
Nursing
Pharmacy and pharmacists
Physical medicine and rehabilitation
Nutrition
Physical therapy/occupational therapy
Respiratory therapy
Social work
Speech language pathology and swallowing
Stroke system administration
Telemedicine support*

EMS indicates emergency medical services.

*Some but not all personnel and services may be needed in specific cases.

play an essential role in the successful formation and function of a stroke center. Advantages of integration include improved communication, ability to obtain consensus with regard to goal setting, identification and use of the strengths of team members, and ability to set common metrics for evaluating performance. Organization of effort can improve survival and recovery after stroke.⁴¹

It is essential that hospital administration and stroke center leaders take the lead in supporting and organizing the multidisciplinary teams that are required to build a successful stroke center. This usually takes the following forms: (1) One or more key administrators in a leadership position takes an active interest or directly participates in and support the activities of the staff providing stroke care; (2) the hospital provides salary support for 1 or more dedicated clinical or administrative stroke coordinators, faculty, and other key personnel; and (3) the hospital supplies resources and infrastructure such as conference space, videoconferencing technology, marketing and communications, and educational resources for staff, patients, and the community. This type of support sends a clear message that the success of the stroke center is an important priority for the hospital.

Within a stroke center, it is essential that the different care teams and disciplines coordinate their efforts and have effective and efficient communication and written protocols for patient transfer. There are several specific processes and transitions of care that are critical and areas in which poor communications can adversely affect the care and outcomes of patients with an acute stroke. Key elements include medical information such as time of onset, stroke severity, changes in clinical status, important laboratory and imaging results, and responses to therapy. Some of the specific care transitions are highlighted in Figure 2.

It is important that each care team (or service, unit, ward, etc) in a PSC or CSC transfer patients using written procedures and protocols that minimize miscommunication and maximize efficient care. This applies to transfers within and between hospitals. Written checklists and procedures are common in other professions such as aviation and the military. The use of read-backs and checklists and uniform adherence to established care protocols are becoming more common in many realms of medical care and may enhance communications and patient care within and between stroke centers.

Policy Recommendation

1. **Different services within a hospital that may be transferring patients through a continuum of care, as well as different hospitals that may be transferring patients to other facilities, should establish hand-off and transfer protocols and procedures that ensure safe and efficient patient care within and between facilities.**
 - a. **Protocols for interhospital transfer of patients should be established and approved beforehand so that efficient patient transfers can be accomplished at all hours of the day and night.**

Initial Assessment, Stabilization, and Care at the Hospital

Initial Assessment and Stabilization

Regardless of a hospital’s specific evaluation and treatment capabilities with respect to cerebrovascular disease, each should have a policy that indicates the type and level of care it can provide. These capabilities should be communicated to the local municipal and regional EMS authorities. The policy

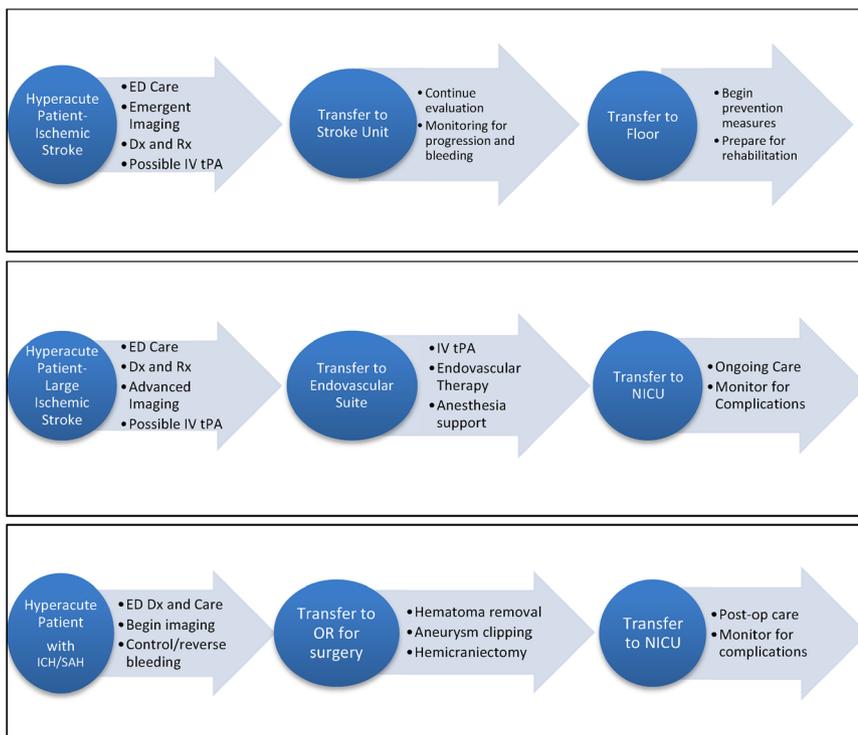


Figure 2. Examples of care transitions among staff, specialists, and care areas. Specific tests and treatments are for illustrative purposes only and do not endorse or exclude any test or treatment for a specific patient or disease. Each transition (as depicted by arrows) requires a complete and accurate handoff between care providers as the patient progresses from one care setting to another. This Figure is for illustrative purposes only and is not intended to include or exclude any specific treatments, services, or providers for each condition. Dx indicates diagnosis; ED, emergency department; ICH, intracranial hemorrhage; IV, intravenous; NICU, neurological intensive care unit; OR, operating room; Post-op, postoperative; Rx, treatment; SAH, subarachnoid hemorrhage; and tPA, tissue-type plasminogen activator.

should be incorporated into local and regional bypass policies along with other considerations such as a patient's stroke syndrome severity, stability, symptom duration, eligibility and need for acute treatment(s), and local logistics.

The initial evaluation is aimed at stabilizing vital functions, establishing a definitive diagnosis of stroke by excluding a stroke mimic, and determining the type of stroke. Patients with an acute ischemic stroke (AIS) within 3 or 4.5 hours may be candidates for intravenous tPA therapy. Patients with a hemorrhagic stroke may require reversal of anticoagulation, reduction of systemic blood pressure, treatment of increased intracranial pressure, and in some cases drainage of acute intraventricular blood, as well as acute removal of the hematoma by neurosurgery.

Hospital Care

The first component of the medical evaluation is to obtain a focused history and perform general and neurological examinations. The history should clearly establish the time of symptom onset (or last known normal) and identify conditions that may preclude the use of intravenous thrombolytic drugs and other acute therapies such as endovascular treatments.^{23,42–47} By definition, patients who awaken with a new focal neurological deficit are assumed to be last known normal when they went to bed (assuming they were normal at that time).

The general physical examination should include airway assessment, breathing, circulation, temperature, and blood oxygenation (Table 1).^{47–52} The assessment should include rapid pulmonary, cardiac, and abdominal examinations. The National Institutes of Health Stroke Scale (NIHSS) has been used as a standardized measure of ischemic stroke severity.⁵³ The use of other neurological severity scoring systems, such as the ICH score (for an intracranial hemorrhage) and the Hunt and Hess score (for a subarachnoid hemorrhage), is now required for hospitals that seek to be certified as a CSC by The Joint Commission.

Laboratory testing should include serum glucose, electrolytes and renal function, complete blood count (including platelet count), prothrombin time (with international normalized ratio),⁵⁴ activated partial thromboplastin time and renal function, and markers of cardiac ischemia.^{29,47,55} The results of these tests should not delay the initiation of intravenous tPA therapy unless there is suspicion of a blood dyscrasia, coagulopathy, or recent use of an anticoagulant.

The tests listed above and other studies discussed below should be performed consistent with national guidelines related to stroke care.⁴⁷ Testing for fecal occult blood is not routinely performed unless there is a history of recent gastrointestinal disorders. More detailed evaluation of coagulation status, including platelet function, thrombin time, ecarin clotting time, and factor Xa levels, may be useful in the evaluation of patients with hemorrhagic strokes or patients taking the newer classes of oral anticoagulants. Arterial blood gases, urine toxicology, blood alcohol levels, and pregnancy testing depend on the clinical scenario. A 12-lead ECG is recommended for all stroke patients, and a chest radiograph is also recommended if there are specific indicators.^{47,56}

Neuroimaging is essential to differentiate between ischemic and hemorrhagic strokes, exclude other intracerebral

lesions, and plan further therapies.^{39,57–63} Noncontrast cranial computed tomography (brain CT) is most readily available. CT is exquisitely sensitive to intracranial hemorrhage and can be performed rapidly as part of the acute stroke evaluation. Brain magnetic resonance imaging may be used instead of CT in some centers but should not delay treatment. Many centers now use magnetic resonance imaging to better image and define the type and location of the ischemic stroke.

Advanced brain and neurovascular imaging are being used with increasing frequency to better characterize the type and location of a stroke, define the underlying vascular lesion(s), and determine whether there is potentially salvageable brain (penumbra) that might be a target for endovascular therapies. Modalities such as magnetic resonance imaging, magnetic resonance angiogram, CT angiography, magnetic resonance diffusion/perfusion, and CT perfusion can be performed safely and rapidly in an emergent setting in many hospitals. The identification of an aneurysm or arteriovenous malformation in patients with a subarachnoid hemorrhage or intracranial hemorrhage may prompt early neurosurgical or endovascular intervention in some cases.

Detailed recommendations for the management of patients with ischemic stroke, transient ischemic attack, intracranial hemorrhage, and subarachnoid hemorrhage are provided in recent American Heart Association guidelines.^{47,64,65} There are also recent guidelines that address approaches and specific therapies for secondary prevention.⁶⁶

Policy Recommendation

- 1. All hospitals caring for stroke patients within a stroke system of care should develop, adopt, and adhere to care protocols that reflect current care guidelines as established by national and international professional organizations and state and federal agencies and laws.**

Transfer Protocols and Criteria

Transfer protocols and criteria differ depending on whether the patient had an ischemic or hemorrhagic stroke and on the required resources and expertise. The adequacy of the patient's vital functions (ie, airway respiratory and circulatory status) must be rapidly assessed and stabilized before neuroimaging is performed or hospital-to-hospital transfer takes place.^{47,64,67} If the patient is suitable for intravenous tPA treatment, then treatment should be administered at any appropriate facility before transfer to an advanced center (PSC or CSC) for further management, if appropriate.⁶⁸

During the initial management and transport, certain measures should be undertaken to prevent or minimize mechanisms and processes that may worsen the ischemic or hemorrhagic injury. For AIS, hypotension or lowering of the blood pressure should be avoided, because this may extend the area of irreversible ischemic injury, except if the pressure is >220/120 mm Hg or is causing acute end-organ injury such as acute myocardial infarction or if the patient has received intravenous tPA (after which an absolute maximum blood pressure of 180/105 mm Hg is recommended). For patients with an intracranial hemorrhage or subarachnoid hemorrhage, the systolic blood pressure goal is <150 to 160 mm Hg.⁶⁹

Neurosurgical consultation should be obtained for patients with parenchymal or subarachnoid hemorrhage. Ventriculostomy may be required if obstructive hydrocephalus is present, and surgical evacuation of a cerebellar hemorrhage can be lifesaving. As discussed above, a coagulopathy should be urgently reversed. Antiepileptic medication should be administered in instances when witnessed or suspected seizures have complicated the patient's early clinical course. Until neurosurgical evaluation is obtained, other measures to control intracranial pressure should be considered, such as intubation with modest hyperventilation, furosemide, mannitol, or hypertonic saline.^{50,70-80}

The use of telemedicine for stroke care, so-called telestroke, has increased the frequency of "drip-and-ship" treatment, in which patients are diagnosed and treated locally with intravenous tPA and then transferred to a PSC or CSC-type facility for admission and further management. This approach can be used safely, with a high rate of success and a low rate of protocol violations.^{81,82} These communications should include at least audio interactions between the referring hospital and stroke center (PSC or CSC). A real-time audiovisual link enhances the assessment of the patient's neurological status and reading of the outside CT or magnetic resonance imaging scans. Placement of a call to the receiving ED before transfer also enhances the efficiency of care. These steps are discussed below in more detail.

Practices vary regarding when hospitals should arrange patient transport to another facility after the patient receives intravenous tPA treatment. Some hospitals transport patients while they are receiving intravenous tPA; others mandate that the infusion be completed before transportation. One factor to consider is angioedema of the face/tongue/pharynx, which can occur in 0.5% to 1% of patients who are treated with intravenous tPA (although up to 5% may show lesser degrees of edema).^{83,84} Typically, the angioedema occurs within 2 hours of the start of the infusion.⁸⁵ The use of angiotensin-converting enzyme inhibitors is a major risk factor for the development of angioedema⁸⁶; however, this should not be considered a contraindication to the use of intravenous tPA in otherwise-eligible patients.

On the basis of these concerns, it might be prudent in some cases to wait for the infusion to be completed before transporting low-risk patients and to wait 60 minutes after the infusion is completed before transporting high-risk patients (ie, those who have recently received angiotensin-converting enzyme inhibitors). Others might suggest that all patients be transferred immediately even if the intravenous tPA is still infusing, so as not to delay possible endovascular therapies. This is not unreasonable, but with the recent cessation of the Interventional Management of Stroke (IMS) III study because of futility (but not safety), the reasoning behind such rescue therapy is less compelling.⁸⁷ Indeed, with the negative outcomes of the IMS III, MR RESCUE (Mechanical Retrieval and Recanalization of Stroke Clots Using Embolectomy), and SYNTHESIS Trial (Local Versus Systemic Thrombolysis for Acute Ischemic Stroke) studies, the rationale behind transfer of such patients for acute endovascular therapy should be reconsidered.^{87-89a} However, this is an evolving area, and

changes in this care paradigm may occur as more data from other ongoing trials become available. Because data on the preferred approach in terms of transportation during and after intravenous tPA therapy are limited, hospitals and systems should develop policies that reflect patient needs and local care practices.

As noted above, the transfer of patients between facilities should include establishment of written protocols that detail criteria for such transfers, who and when to call to arrange such a transfer, how the patient is monitored during the transfer, and how to communicate the outcome of each transfer. Because of medicolegal considerations, it might not be possible in all areas to have specifically defined transfer hospitals that are contractually arranged; however, we do favor at least an informal type of arrangement between hospitals that have (in the past) or are likely (in the future) to have high volumes of patients transferred between each facility.

Telemedicine

Telemedicine for Acute Stroke (Emergency Phase)

Whenever local or onsite acute stroke expertise or resources are insufficient to provide around-the-clock coverage for a healthcare facility, telestroke systems should be considered and implemented to supplement resources at participating sites in the context of a stroke system of care or stroke network.⁹⁰ Adopted quality improvement initiatives should assess successful implementation and use of technology, rates of technical and human failures that interfere with or prevent a consultation from occurring, and the needs of attaining and maintaining clinical and technical competency.⁹⁰⁻⁹²

Healthcare facilities preparing to develop "hub-and-spoke" telestroke networks should include membership from every key stakeholder to ensure successful adoption and promote sustainability (Figure 3). Successful adoption usually incorporates broad representation of multiple groups, as noted above. Special support is needed from information technology, legal, credentialing, clinical operations, billing, and bed control.⁹⁰⁻⁹⁴ Many of these elements must be addressed at both the sending and receiving facilities. A full description of interactions between stroke systems of care staff can be found in "Interactions Within Stroke Systems of Care."

Healthcare organizations providing or requesting telestroke services within a regional stroke system of care must operate under certain principles set out in contractual agreements between parties.⁹⁰ Contracts must address, at a minimum, costs of developing and maintaining the network; compliance with local statutes, boundaries, and noncompete relationships; medicolegal risk; malpractice insurance; regulations governing the sharing of protected health information; licensing and credentialing of telestroke providers; establishment of a reimbursement for professional services at fair market value; and delineation of roles and responsibilities of all clinical, administrative, and technical personnel at both the hub and spoke ends of the telestroke interaction.⁹⁰

Remote consultative services using telemedicine should be provided in a manner akin to that which occurs in a face-to-face encounter onsite, and the dictation/transcription of the consultation details and recommendations should be

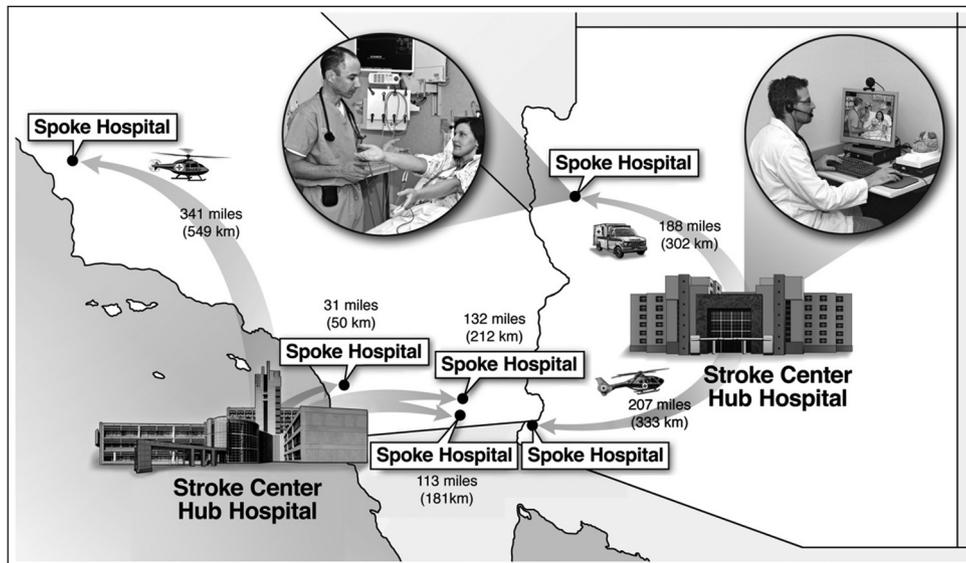


Figure 3. Telestroke network (hub-and-spoke model). Mayo Clinic illustrator performed design; people depicted are volunteer personnel/actors (not patients); permission/authorization on file at Mayo Clinic.

maintained at the hub hospital and transmitted to the spoke hospital in a timely fashion and with appropriate patient identifiers that ensure accurate attribution.⁹⁰ Patients or their surrogate medical decision makers, if applicable, must be made aware of the indications, benefits, and risks of a telemedicine consultation for stroke and grant consent for this activity (as appropriate).⁹⁰

A reliable dedicated mechanism for accessing the telestroke system (eg, centralized paging, direct telephone account) must be available to ensure that the requesting personnel at the spoke hospital can be connected to the consulting personnel at the hub hospital promptly.^{91–93} Depending on the nature and sophistication of affiliation between hub and spoke facilities, patients with an acute stroke may undergo a virtual registration process at the hub facility, which subsequently eases storage and transmission of electronic medical records. In this case, appropriate privacy notification and policies should be provided to the patient.⁹¹

Class I recommendations based on level A evidence support the use of high-quality videoconferencing systems for performance of a National Institutes of Health Stroke Scale assessment and US Food and Drug Administration–approved teleradiology systems for timely review of brain imaging.⁹⁵ Telestroke providers should have a range of applicable technological tools, including 2-way audiovisual communication with either fixed, mobile, or robotic platforms; laptops/ultramobile portable computers; personal computers; headphones with microphones; webcams; access to picture archiving and communication systems; smart phones; or computer tablets (Table 3).^{92,93}

Recommendations concerning technology providers, technological approaches, and technical specifications have been published previously.⁹⁰ In addition, The Joint Commission and the Centers for Medicare and Medicaid (CMS) have rules and regulations related to the credentialing of physicians to participate in telemedicine-based care, deal with malpractice issues, and receive reimbursement. Some of the legal issues are discussed below in more detail. Telehealth services billing is only allowed if Telehealth provides medical services to an underserved geographic area.

We suggest that key stakeholders work together to generate candidate performance measures for telemedicine related to stroke. Parameters for such measures might include time to establishing a telemedicine link, technical quality of the connection, results of the consultation, treatment complications, patient and provider satisfaction, accuracy of the information obtained, and time to complete a patient transfer. The models and codes for reimbursement of telestroke services in the context of stroke systems of care are addressed in “Reimbursement Issues.”

A cost-effectiveness analysis was conducted to compare hub-and-spoke telestroke networks with usual care (remote emergency physicians without telestroke consultations or local stroke experts). The analysis used a decision analytic model and was developed for both the 90-day and lifetime horizons. Quality-adjusted life years gained were combined with costs to generate incremental cost-effectiveness ratios. Compared with usual care, telestroke networks resulted in an incremental cost-effectiveness ratio of \$108 363 per quality-adjusted life year in the 90-day horizon and \$2449 per quality-adjusted life year in the lifetime horizon (<\$50 000 per quality-adjusted life year, a ratio commonly considered acceptable in the United States). When the lifetime perspective is considered, telestroke networks are cost-effective compared with usual care, because telestroke costs are immediate but benefits of improved stroke care are realized over the long-term.⁹⁶

Telemedicine for Subacute Stroke, Secondary Prevention, and Rehabilitation

Telemedicine is also useful to provide stroke consultation for patients with a subacute stroke, for patients already hospitalized with stroke or transient ischemic attack, for supplementation of existing stroke care processes, to advise about stroke origin/cause and mechanism, to design appropriate secondary stroke prevention regimens, to determine rehabilitative needs, and for planning of disposition and reintegration into community and home environments for poststroke care.^{66,90}

In this regard, telestroke systems may support sustainable stroke care in hospitals that otherwise would be unable to

Table 3. Attributes of High-Quality Videoconferencing and Teleradiology Systems Suitable for Clinical Interactions

Features	Requirements
Speed	Consistent bidirectional synchronized audio and video at a resolution capable of being accurately displayed at ≥ 20 frames/s on monitors of ≥ 13 in
Latency	Consistently ≤ 500 ms
Color	Full color
Camera	Far-end control of full optical zoom and pan-tilt support of remote (at patient bedside) camera
Interactivity	Full duplex interactive video and audio signal processing, ideally with noise or echo processing to improve sound quality
Quality control	When appropriate, the devices and any peripheral sensors should meet relevant FDA standards for MDDS. MDDS are hardware or software products that transfer, store, convert formats, and display medical device data.
Security	Meet or exceed current privacy regulations for encryption and user authentication
Legacy integration	Support at minimum older models of the same manufacturer but have the capability to integrate some common device platforms from other manufacturers
Adaptive design	Support at a minimum 2 conference participants in full interactive mode, ideally with support for additional participants to join. Ability to create connections ad hoc without preprogrammed participants.
Scalability	Should be able to meet the needs for expanded use with purchase of additional modules or devices
Connectivity	At minimum, operate over fixed private ISDN or IP networks; ideally, should be capable of secure, high-quality conferencing over public IP networks
Radiology format	Adherent to FDA standards for teleradiology systems for diagnostic purposes with transmission of the full DICOM data set
Redundancy	Have at least 1 backup system readily available should the main system break down

DICOM indicates digital imaging and communications in medicine; FDA, US Food and Drug administration; IP, Internet protocol; ISDN, integrated services digital network; and MDDS, medical device data systems.

Modified from Schwamm et al.⁹⁵ ©2009 American Heart Association, Inc.

provide it, as well as greatly extend expert care into smaller communities. This expanded mission of telestroke systems, which goes beyond equipping EDs to become acute stroke-capable sites for thrombolysis assessment, represents a major opportunity to improve the care of stroke patients in the United States. The success of such programs may depend in part on local expertise and resources, because remote care has limitations. This paradigm has been successful in European stroke center implementations of telestroke (Telemedical Project for Integrative Stroke Care [TEMPIS])⁹⁷ and is an important component of providing patient-centered, accessible, and affordable high-quality stroke care after rehabilitation and discharge.⁹⁸ This is an extension of the concept of an electronic ICU (eICU), in which telemedicine techniques are used for remote coverage of patients in an ICU.⁹⁹ Of course, such remote coverage has limitations in terms of procedures and some examination features and may not be appropriate under all circumstances.

Policy Recommendation

- 1. Because of the limited distribution and availability of neurological, neurosurgical, and radiological expertise, the use of telemedicine/telestroke resources and systems should be supported by healthcare institutions, governments, payers, and vendors as one method to ensure adequate 24/7 coverage and care of stroke patients in a variety of settings.**

Principles on Rules and Regulations

Any stroke system of care will exist in an environment in which various organizations, agencies, and government authorities will have some input into its elements and operations and interest in its outcomes. This section will provide some overall guidance and principles for addressing these issues, keeping in mind that there will be substantial variations in how these are developed and implemented in different cities, states, and regions.

Recent experience with setting up stroke systems of care shows that several elements are either highly regulated or are subject to some degree of control via rules and regulations. These include (1) the EMS system, (2) stroke center formation and certification, (3) the interactions between EMS and stroke centers, and (4) the training, education, and certification of individual healthcare providers. Each will be addressed below.

EMS System

The EMS system in the United States is highly fragmented and regionalized. It is typical that EMS within a state is divided into various subregions or districts that may or may not follow the boundaries of a city, county, or other designated area.^{100–102} Each EMS provider can be under local autonomous or semi-autonomous control with various degrees of state and federal oversight. There are currently limited or no national guidelines for the training of EMS personnel in the recognition and treatment of patients with a possible stroke. In some areas, a stroke call is not even a high-urgency situation that prompts an immediate response. Despite these limitations, there are abundant data that stroke patients who enter the medical system via a 9–1–1 call typically receive more timely care and are more likely to be treated with intravenous tPA.^{10,103–105}

In setting up any stroke system of care, it is vital for the organizers to (1) determine how the area's EMS is organized, or establish an EMS system if one does not exist; (2) ensure proper stroke-related education and training of EMS personnel; (3) strive to ensure that a stroke call is assigned the highest priority and response by EMS; (4) set up a data collection paradigm to determine response times and outcomes; and (5) develop an action plan to address any deficiencies in the EMS response.

Stroke Centers

Stroke centers are the backbone of any stroke system of care. The major types and functions of different types of stroke centers have been reviewed above in "Levels and Types of Hospital Care." This section discusses the rules and regulations that govern the formation and operation of stroke centers. Stroke centers are almost always a part of a hospital, hospital network, or regional healthcare system. At a minimum, the

parent hospital must be certified by a recognized organization that is independent of the hospital and has the experience and resources to ensure that all patients receive proper care in a safe and efficient setting. There are several regional and national organizations that provide overall hospital accreditation.

As the number of PSCs has increased, several organizations have developed certification programs for such centers. The Joint Commission has the most experience in this arena, having certified ≈950 hospitals as PSCs as of early 2012. Other entities such as the Health Facilities Accreditation Program, Das Norsk Veritas, and various state governments have also developed certification programs. Recently, the American Heart Association/American Stroke Association announced a partnership with The Joint Commission in the stroke center certification process. The Joint Commission developed and began a certification program for CSCs in September 2012.¹⁰⁶

Certification of stroke centers is an important effort to ensure that such centers deliver state-of-the-art care in a safe, efficient, and consistent manner and are adherent to all relevant guidelines. It is important that such certification processes meet certain criteria: (1) They should be performed by an independent entity (not hospital-based self-certification); (2) certification should include a site visit and assessment of personnel, infrastructure, and protocols; (3) the process should include assessment of various disease performance measures; and (4) the complexity, costs, and frequency of the certification should be consistent with the level of the stroke center and types of patients cared for at the facility.³⁰ Ideally, over time this process will move to incorporate the public reporting of adherence to recommended evidence-based measures.

Interaction Between EMS and Stroke Centers/Hospitals

The interaction between the EMS system and hospitals in general and stroke centers in particular forms one of the key components in a stroke system of care. In some cities, regions, and states, a very clear and efficient system exists by which EMS responders are directed to the nearest appropriate stroke center facility. This is often based on a hospital's designation as a stroke center, its availability and capability to accept new patients, and the ability of EMS to bypass other facilities to reach a stroke center, assuming the patient is otherwise stable enough for the trip. Many cities, counties, regions, and states have committees that oversee these efforts and coordinate plans and programs among the various stakeholders. This type of organization appears to promote an efficient system of care and can fairly rapidly address problems as they arise. Examples include Texas, Florida, and Illinois.

In some cases, this type of bypass or preferential triage has been established by EMS system rules and regulations in conjunction with local and state government (eg, the department of public health), fire departments, hospital networks, and hospital associations.^{107–109} In other cases, a city or state has passed a law that codifies the diversion of ambulances to a stroke center facility if they have a patient with a suspected stroke (often supported by objective data). States with such laws include New York, Florida, and Illinois. Such laws often define different levels of stroke centers and how such facilities are recognized in terms of criteria and certification.

There are many examples of this process being successfully developed and implemented. Cities such as Houston, TX, have been diverting patients to stroke centers for many years, as have the states of Maryland, Massachusetts, New York, and Florida. Other states such as Illinois recently passed laws and then developed a diversion plan and policies to implement the new law; however, the implementation of the law has taken place slowly because of the development of specific bypass plans in each EMS region of the state.

In cities and states where such processes have been developed successfully, several themes have emerged that should guide ongoing and future efforts. Often the effort has had leadership from a very senior political level (eg, governor, mayor) or has been led by champions who may be healthcare providers or even patients. It is common for a state to form a stroke task force or for the governor to set up an advisory council to develop and bring forward such plans.¹¹⁰

Medical personnel cannot work in a vacuum to accomplish this level of integration and cooperation. It takes a broad coalition (including government officials) to move this type of effort forward. The leadership should determine broad goals and benchmarks but be flexible in terms of how these can be best reached based on local factors, financial limitation, logistical issues, and medical best care practices.

We believe there are several key principles that should be followed for such rules and regulations to be established and function as planned: (1) Any new rule, regulation, or law should be developed by a multidisciplinary team of experts with experience in the area of healthcare delivery; (2) the process should be transparent and flexible so that all stakeholders have input; (3) specific goals and criteria should be defined early in the process to help focus the group's efforts; (4) there should be a timeline for the passing of any new law or regulation and a timeline for its implementation; (5) there should be a data collection and analysis process so that the success of a new rule/law can be judged; and (6) based on the data, the rule/law should be modified to address local issues and improve patient care.

Several common problems have emerged from past efforts. Examples include overcrowding of EDs (which limits their ability to accept additional patients), EMS concerns about diverting resources out of their designated areas (thereby leaving some areas "uncovered"), lack of an adequate number of stroke centers to make diversion logistically feasible, dealing with stroke centers on bypass because of overcrowding, and the need for ongoing training of EMS personnel.

Each of these issues is manageable by a consideration of how the system of care will work once fully implemented. For example, the issue of lack of ED resources and ambulance coverage is a common concern. It should be recognized that these patients are already in the healthcare system, and they will likely be transferred to the proper hospital at some point. The use of EMS resources and hospital beds may be more efficient if the patient is initially transported to the most appropriate hospital (ie, a stroke center) than if the patient goes to a less prepared hospital where an evaluation is begun, then the patient is transferred in a few hours or a day to a different hospital.

Healthcare Provider Training and Certification

A stroke system of care involves healthcare professionals spanning the spectrum of care, from EMS personnel to physicians, nurses, physician extenders, therapists, and discharge planners. The training and education of EMS personnel is typically included within a curriculum of dozens of topics; stroke may be assigned less than an hour of formal education in many cases. Considering the prevalence of stroke and the time-sensitive nature of stroke care, stroke education should be allocated a time block for EMS training that is roughly equivalent to acute coronary syndromes. Important aspects should include teaching of more complete neurological assessment skills. Simulations are being used with increasing frequency to train responders with regard to a variety of emergency conditions.

Recommendations for PSCs and CSCs include some guidance for ongoing education of key personnel (ie, physicians and nurses). Although some personnel at these facilities had concerns about these educational requirements, subsequent studies have shown the importance of these elements for the successful operation of a PSC.¹⁰⁹ The specific number of hours of stroke-related education is cited in the PSC and CSC recommendations.

A PSC and CSC should also provide education to its employees, regional healthcare providers, EMS, and lay groups. Public education could focus on stroke risk factors (screenings for hypertension and other risk factors), as well as the recognition of acute stroke symptoms. A minimum of 2 professional and 2 public programs each year are suggested.³⁰ These programs should be integrated across the spectrum of care within a stroke system.

Policy Recommendation

1. **Cities, counties, regions, and states are urged to develop an organizational infrastructure and decision-making body to assist in addressing care issues, decision making, implementation, and problem solving.** This is typically in the form of a stroke committee defined by a region or other overseeing body.
 - a. **All of the elements of a stroke system of care will operate in a highly complex and multidisciplinary environment with many elements and stakeholders, each with their own rules and regulations.** In terms of the many controlling authorities, it is paramount that the “best interests of the patient” be the primary concern and driving factor when any rules and regulations are made and implemented.

Reimbursement Issues

The relationship between hub-and-spoke hospitals, other facilities, and healthcare providers within a stroke system of care must consider various financial issues. Reimbursement for the care of stroke patients at each element of the stroke system must be adequate to compensate healthcare providers for their services. By participating in a stroke system, some hospitals may be bypassed by EMS with acute stroke patients and possibly other medical emergencies that either mimic acute stroke or are nonstroke emergencies. Other hospitals may see an increase in stroke admissions. Indeed, enhancement of the

hospital's reputation for acute emergent care will increase stroke admissions and perhaps admissions for patients with other diagnoses that may mimic stroke. Hub hospitals receive transfers from the community hospitals after stabilization and acute therapy or when indicated for advanced therapies such as interventional and endovascular procedures. The relationships may also result in transfers of other patients who require tertiary care for conditions unrelated to stroke.

In 2005, hospital diagnosis-related group (DRG) reimbursement for stroke was revised to reflect the increased costs associated with intravenous thrombolytic therapy. In addition to the cost for intravenous tPA used to treat AIS, the resources necessary to care for a patient after thrombolysis result in substantially higher expenses, estimated at ≈\$13 000 per patient.¹¹¹ Hospitals are reimbursed by use of DRG codes 61 to 63, designated for patients with AIS treated with intravenous tPA, which provides an increase in payment of \$4000 to \$6000 (Table 4).

For patients treated with intravenous tPA for stroke and then admitted to the same hospital, this additional payment at least partially compensates for the higher costs associated with thrombolytic therapy. Unfortunately, the current DRG system does not reimburse hospitals when patients are treated at a community or spoke hospital and then transferred to a stroke center for post-intravenous tPA care (drip-and-ship patients). The DRG associated with thrombolysis cannot be used by a receiving hospital because the intravenous tPA was not administered by that facility. The spoke hospital, however, is only reimbursed for the direct cost of the tPA. The receiving hospital incurs all the additional expenses associated with the care of a patient treated with intravenous tPA but does not receive the higher payment designed to compensate for the additional expenses. This inequity could discourage stroke centers from accepting transfers of acute stroke patients, but to date, CMS has not changed the billing codes. This may be based in part on the relatively small number of patients who are treated and rapidly transferred.

In some cases, stroke centers receiving patients already treated with intravenous tPA can recover costs through other highly reimbursed DRGs. If endovascular therapy is indicated and intra-arterial tPA is given, the hospital is eligible for payment of the DRGs for stroke with administration of thrombolytic drugs. In addition, use of US Food and Drug Administration–approved mechanical clot retrievers (devices approved by the US Food and Drug Administration for removal of blood clots from brain arteries) allows hospitals to use a DRG with a substantially higher reimbursement than for stroke patients either with or without intravenous tPA treatment. Although only a minority of transferred stroke patients require endovascular therapy, the higher DRG payment at least partially offsets the losses incurred by treating the drip-and-ship patients.

Reimbursement for physician time associated with the care of acute stroke patients does not depend on the DRG system. Physicians administering intravenous tPA may bill for critical care time based on total time at the bedside caring for an acutely ill patient. After transfer, patients treated with intravenous tPA are typically cared for in a stroke unit or ICU,

Table 4. DRG Payment

MS-DRG	Description	2011 National Average Urban Payment	Comments
061	Acute ischemic stroke with tPA with MCC	\$16511	Billed by hospital only if tPA administered and patient admitted
062	Acute ischemic stroke with tPA with CC	\$10877	Billed by hospital only if tPA administered and patient admitted
063	Acute ischemic stroke with tPA without CC/MCC	\$8516	Billed by hospital only if tPA administered and patient admitted
064	Intracranial hemorrhage or cerebral infarct with MCC	\$10428	Billed by hospital if no thrombolytic drugs used or given at outside hospital before transfer
065	Intracranial hemorrhage or cerebral infarct with CC	\$6515	Billed by hospital if no thrombolytic drugs used or given at outside hospital before transfer
066	Intracranial hemorrhage or cerebral infarct without CC/MCC	\$4578	Billed by hospital if no thrombolytic drugs used or given at outside hospital before transfer
023	Craniotomy with major device implantation with MCC	\$28414	Billed by hospital if mechanical embolectomy performed
024	Craniotomy with major device implantation without MCC	\$19518	Billed by hospital if mechanical embolectomy performed

CC indicates complication or comorbidity; DRG, diagnosis-related group; MCC, major complication or comorbidity; MS-DRG, Centers for Medicare and Medicaid Services Medicare severity diagnosis-related group; and tPA, tissue-type plasminogen activator.

and physicians at the stroke center that receives the patient may also use critical care codes to bill for time spent caring for acute stroke patients. For patients who are not transferred, subsequent inpatient services provided via telemedicine may be allowable under certain circumstances.

Stroke centers and community hospitals should be aware of the financial implications of patient triage and transfer agreements. There is a risk that some triage paradigms might adversely impact one type of hospital and benefit another. These potential issues should be tracked prospectively and addressed as a stroke system evolves. Although patient care remains the major consideration, measures that adequately compensate hospitals and physicians for stroke care are highly encouraged and contribute to effective interactions within stroke systems. Because of the complex and lengthy process required to change hospital and physician reimbursements, any changes should be initiated years before any planned increases in reimbursements are going to be realized.

Policy Recommendation

- 1. Government agencies and third-party payers are urged to develop and implement reimbursement schedules for patients with acute stroke that reflect the demanding care and expertise that such patients require to achieve an optimal outcome, regardless of whether they receive a specific medication or procedure.**

Legal Issues in Stroke Care

Contemporary stroke care requires a team approach from highly trained clinicians and other healthcare providers, along with technologies not available in many hospitals. Given the disparity of hospital capabilities, systems must be established to ensure as many stroke patients as possible have access to the care that has the greatest potential to improve outcomes. Health care, however, is a highly regulated industry. Development and implementation of a “systems” approach to

acute stroke care must be undertaken with sensitivity to the complex intricacies of local, state, and federal laws that govern all aspects of patient care.

A systems approach to acute stroke care seeks to provide the greatest benefit to the largest number of patients by crossing traditional boundaries. System plans will differ because of variables such as geography and the resources available. Nevertheless, all systems will need to address the several legal concerns: (1) Liability inherent in the evaluation and treatment of AIS syndromes; (2) regulatory, licensing, and liability issues of remote consultation or “telemedicine”; and (3) pre-hospital diversion and interhospital transfer of patients with AIS to stroke centers.

Liability Issues in the Evaluation and Treatment of Acute Stroke

Before 1995, lawsuits alleging a missed or delayed diagnosis of an AIS were relatively rare. The reason these lawsuits were rare was simply the lack of effective therapy available to treat the acute phase of an ischemic stroke. A plaintiff can only succeed in prosecuting a claim if the plaintiff can show the physician was negligent in missing the diagnosis and the outcome would have been better had a timely diagnosis been made. With the approval of intravenous thrombolysis (intravenous tPA) as an effective treatment and the availability of sophisticated intra-arterial clot lysis and clot retrieval at some comprehensive stroke centers, the bar has been raised. AIS patients who are not offered thrombolysis in a timely fashion may allege a poor outcome is related to the physician’s failure to offer effective, approved treatment. Despite this paradigm shift, some physicians have resisted using intravenous tPA as a treatment for AIS patients.¹¹³

Many physicians have concluded that if an AIS patient has a symptomatic hemorrhagic transformation after intravenous thrombolysis, they may be sued simply because the outcome was worsened by the treatment. This concern has fostered a reluctance to treat AIS patients with intravenous tPA.¹¹⁴ An

analysis of stroke-related lawsuits, however, showed the greater legal risk falls on the side of not offering intravenous thrombolysis to eligible AIS patients. Liang and Zivin¹¹⁵ reviewed 33 lawsuits involving an allegation of negligent care in treating an AIS patient. Adverse outcomes after intravenous tPA were an element of only 4 of the 33 lawsuits; failure to offer intravenous tPA was the allegation of negligence in 29 of the 33 lawsuits.¹¹⁵

It should be concluded that the evaluation and treatment of patients with acute stroke syndromes may involve substantial risk of liability. The outcome for AIS patients is closely tied to timely treatment. Hospitals that profess themselves to be stroke centers must ensure protocols are in place to expeditiously evaluate and treat AIS patients. If a hospital lacks the capability of a stroke center, it will need to develop protocols that allow for rapid evaluation of patients presenting with signs of an AIS. Eligible patients should be treated within the capability of the hospital or transferred in a timely manner for appropriate therapy.

Remote Consultation and Telemedicine

Only a small number of hospitals currently offer the full array of interventions found at CSCs. A larger number of hospitals are able to offer intravenous tPA but lack the staff and facilities to offer more sophisticated treatments, such as clot retrieval or intra-arterial fibrinolytic drugs. Many of these hospitals would benefit from real-time advice from a vascular neurologist or review of the patient's CT by a qualified specialist such as a neuroradiologist. Some hospitals and physicians already obtain remote consultations through phone consultations or more sophisticated means of telemedicine. Legal issues raised by these remote consultations include the following: (1) Licensing: Does a specialist need to be licensed in a state to give phone advice or evaluate a patient through telemedicine? (2) Are practitioners who engage in telemedicine or phone consultations at increased risk for civil liability? (3) Will specialists be reimbursed for telemedicine consultations?

The licensing and regulating of medical practice is primarily a function of state governments. State regulation of medical practice is reflected in statutes enacted through the legislative process and regulations promulgated by state medical boards. Various proposals have been advanced to standardize licensing procedures and to allow for remote consultations from physicians licensed in a state other than the patient's home.

The Federation of State Medical Boards has proposed model legislation that would facilitate consultations via telemedicine.¹¹⁶ Because any change in the regulation of medical practice must be accomplished through the political process,¹¹⁷ there is significant disparity among the states concerning the need for licensing and regulation of physicians who provide remote consultations via telemedicine.¹¹⁸ Although efforts should continue to standardize the regulation of remote consultations, stroke systems that use telemedicine now should obtain individual legal advice on licensing requirements within their own individual state and jurisdiction.

Physicians who provide remote consultations through telemedicine often wonder if they are increasing their risk of liability. Any time a physician provides professional advice directly to a patient or to a requesting physician, there is a risk that negligent

services could result in liability for consequent damages. The provision of consultative services through telemedicine carries the same risk. The physician who consults on out-of-state patients through telemedicine technology runs the additional risk of being sued in the patient's home state rather than the physician's domicile.¹¹⁹ Generally, a state will apply its "long arm" statute, granting it personal jurisdiction over an out-of-state physician who is providing regular consultations to its citizens.¹²⁰ Physicians providing out-of-state telemedicine consultations should assume that they might be subject to a medical malpractice suit in the patient's state. Should such a suit arise, it is likely the forum state would apply its own law to the case rather than the laws of the physician's home state.¹²¹ Consequently, physicians engaging in telemedicine consultations outside their home state should check with their liability carrier to ensure any resulting claims would be covered under their professional liability policy.

Remote consultations via telemedicine cannot be sustained on a broad level unless there is appropriate reimbursement for these services. Current CMS policy provides for reimbursement of a professional fee for the consulting physician and a facility charge for the requesting institution, but only if the treating hospital is located in a rural area.¹²² It is estimated that 83% of the US population does not live in a rural area as it is defined under these reimbursement rules. Thus, a substantial number of potential telemedicine consultations would not currently meet CMS criteria for reimbursement. Although there is some disparity among private insurers' willingness to pay for telemedicine consultations, most tend to follow CMS policy. There are ongoing lobbying efforts from several groups seeking to broaden the CMS criteria for reimbursement of telemedicine consultation in acute stroke.

Prehospital Diversion and Interhospital Transfers

Although there are federal and state statutes and regulations impacting prehospital care, most of the control is at the local level. Paramedics and other prehospital care providers operate under standard operating orders approved by the local medical director. In most communities, the EMS medical director should be able to direct diversion of AIS patients to approved stroke centers. Resistance may come from hospitals that do not want to lose patients or from prehospital providers who will be out of service longer as a result of bypassing the closest hospital. Resolving these conflicts is more a political problem than a legal impediment. Because stroke centers generally have been shown to improve outcomes, the policies of many cities and states have shifted in favor of diverting acute stroke patients to such centers.

In addition to prehospital diversion, interhospital transfers will be required if the system is to provide as many stroke patients as possible access to sophisticated treatments. Since 1986, the federal Emergency Medical Treatment and Labor Act (EMTALA) has required Medicare-participating hospitals with specialized services to accept transfer of patients who require the sophisticated evaluation and treatment not available at the transferring hospital.¹²³ Under EMTALA, a stroke center would be required to accept transfer of a patient whose condition cannot be appropriately evaluated and treated at the referring hospital (provided the hospital has the capacity). Although not mandated under EMTALA, prospective transfer agreements and plans would facilitate a systems approach to care of AIS patients.

The development of a systems approach to stroke care will improve outcomes for a large number of stroke patients, but the practice of medicine and the provision of hospital services are highly regulated by state and federal rules and regulations. Therefore, the development and operation of a systems approach must be sensitive to federal, state, and local laws and regulations.

Monitoring/Quality Program and Data Collection Elements

Many of the performance measures for PSCs and CSCs have been codified by the American Heart Association/American Stroke Association's Get With The Guidelines initiative, The Joint Commission, the National Quality Forum, and state or municipal mandates. Additionally, some states, such as New York, profile hospitals' stroke mortality rates as a means of assessing overall stroke quality of care. Similarly, others are proposing to monitor readmission rates for stroke patients as a measure of acute care and continuity of quality. These outcome metrics are generally adjusted to the extent possible for clinical differences in patient risk by use of claims (administrative) data. Few, if any, adjust outcomes on the basis of stroke severity, a key factor in poststroke outcomes. Recent studies¹²⁴ have shown the importance of adjusting stroke outcomes for baseline stroke severity by use of the National Institutes of Health Stroke Scale for ischemic stroke patients. Such baseline severity adjustments must be used when one evaluates treatment outcome for all types of stroke patients.

Beyond those set externally, hospital-specific goals, priorities, and key deliverables may differ from one another based on the center's specific strengths, weaknesses, and unmet needs. For instance, one center may need to focus on establishing rapid and appropriate stroke transfers from affiliated hospitals, whereas another may wish to focus on reducing arrival-to-needle times. Ideally, this goal-setting behavior should include input from many parties, including hospital

administration, the medical director of the stroke center, and members of the frontline stroke team.

This approach of including a broad group in establishing the quality goals is considered advantageous from the point of view of organizational development theory, because it conforms with the classic "form, storm, norm, and perform" model of group development.¹²⁵ This model allows the group to take ownership of its own work and can help reinforce team chemistry and motivation. In this model, teams assemble, generate ideas, identify common goals, and begin to execute effectively. The success of the team is measured by its ability to advance through these different stages of team development.

The metrics that will be measured in a stroke system will include many that are now routinely assessed, such as door-to-needle times for intravenous tPA and time to imaging for the brain CT scan. There will be several new measures that are specific to stroke systems, such as time to establish a telemedicine link and time to transfer a patient.¹²⁶ Other examples of metrics that a stroke system of care might measure are listed in Table 5. These performance measures and metrics apply to patients with all types of stroke.

Whatever center-specific goals are established, all stroke centers must focus on benchmarking and continuous quality improvement. According to classic continuous quality improvement, the key steps are (1) self-reflection (feedback); (2) the identification, reduction, and elimination of suboptimal processes (efficiency); and (3) emphasis on incremental, continuous steps rather than giant leaps (evolution). Ideas generated by the team itself leverage the insight and talents of the participants, tend to be less radical and hence easier to implement, and are often simpler and require little in the way of major capital investment.¹²⁷ Quality intervention is time dependent, and a high level of organization and coordination is required to meet the challenges of delivering stroke intervention as quickly as possible.¹²⁸ Regular analysis and attempts to improve performance and compliance with these metrics form a natural basis for the activity

Table 5. Examples of Quality Performance Metrics in a Stroke System of Care

Metric	Population	Goals	Comments
% of EMS patients triaged to an ASRH, PSC, or CSC	Patients call EMS via 9–1–1 for suspected stroke	Improve presentation times to a stroke center, increase use of acute fibrinolytic therapy	Applies to each city or region with integrated EMS
% of IV tPA–treated patients with a door to needle time of ≤60 min	Patients with acute ischemic stroke eligible for IV tPA therapy	Improve use of IV tPA	Is a national quality metric
Median time to acute reversal of anticoagulation in patients with ICH or SAH	Patients with hemorrhagic stroke and receiving therapeutic anticoagulation	Reduce times to anticoagulation reversal	May reduce expansion of ICHs and SAHs and improve outcomes
Median time to establish a telemedicine link	Patients at a non–stroke center	Improve the efficiency of telemedicine care and expedite stabilization and transfer	Applies to all forms of telemedicine communications and links
Median time from ED arrival to second hospital arrival among transferred patients	Patients at remote facilities who are transferred to a PSC or CSC	Reduce transportation times and improve acute care	Times will vary depending on region and other factors
System-wide risk-adjusted hospital mortality for ICH	All ICH patients (<i>ICD-9</i> 431) admitted via the ED	Measure and improve ICH survival	Would also allow for data collection regarding withholding and withdrawal of care

ASRH indicates acute stroke–ready hospital; CSC, comprehensive stroke center; ED, emergency department; EMS, emergency medical services; *ICD-9*, *International Classification of Diseases, 9th Revision*; ICH, intracranial hemorrhage; IV, intravenous; PSC, primary stroke center; SAH, subarachnoid hemorrhage; and tPA, tissue-type plasminogen activator.

of the stroke team. The goal is to focus internally, attempting to always improve performance over time. If external benchmarks are used, they should be compared on the basis of the hospital's stroke status level. In addition, one should consider the development of metrics that measure the quality of the stroke system itself and its degree of integrated care delivery.

Policy Recommendation

- 1. Each major element of a stroke system of care, as well as the entire system as defined by local or regional factors, should develop and implement at least 2 meaningful quality improvement projects that will result in improved patient care or outcomes.**
 - a. Stroke outcome measures must include adjustments for baseline stroke severity.**

Rehabilitation

This section addresses the provision of rehabilitation services after a hospitalization for an acute stroke. The process examined includes the decision about the type, location, and intensity of rehabilitation services to be provided; implementation of the transfer to a lower level of care; and the interinstitutional communication needed to ensure quality of care during this transition. Neither the provision of rehabilitation services that begins during the acute hospitalization nor the process of care specifically at the site of transfer is addressed.

Rehabilitation Choices at Time of Discharge From an Acute Care Hospital

Rehabilitation services are provided to the majority of patients after a stroke.¹²⁹ Choices regarding the need, intensity, and site of future rehabilitative care are initially made during the acute hospitalization for stroke. This should be an interdisciplinary discussion and choice involving the patient and family or caregivers and multiple health professionals, including the physician, nurses, therapists (physical, occupational, and speech), social worker, discharge planner, and case manager. It requires an understanding of the patient's social situation, including likely discharge destination, premorbid level of functioning, assets for assisting the patient after discharge, the financial and regulatory environment (which may place restrictions on the location, quantity, and type of services that can be reasonably provided), the social support system in various manifestations, patient and family preferences, availability of services, and proximity to family. Multiple medical factors are involved in the decision about a choice of post-hospital rehabilitation services, including the severity and quality of the impairments, the prognosis for recovery, premorbid and current medical problems, and age and sex of the patient. In some circumstances, particularly for long-term rehabilitation, consideration should be given to transferring patients from a PSC or CSC to a location closer to the patient's home town, particularly if they are initially transferred from a remote locale.

Key Criteria Related to the Quantity of Rehabilitation Services Provided at Different Levels of Care

Stroke is the leading diagnosis for patients in acute inpatient rehabilitation facilities (IRF). IRFs are most commonly an

acute rehabilitation unit contiguous with an acute care hospital or a free-standing rehabilitation hospital. Most sites of rehabilitation care are, by regulation, associated with specific criteria regarding the quantity and duration of treatment. Thus, discharge destination location can be viewed as a proxy for intensity and duration of therapy.

For IRFs, CMS requires 3 hours of therapy 5 days per week. Patients in the Medicare program receiving acute rehabilitation are required to have a preadmission screen, have physician documentation of the need for acute rehabilitation within 24 hours of admission, have a review of the plan of care by the physician within 4 days of admission, and receive 3 hours of therapy per day for 5 days a week from 2 or more disciplines. Patients must have a reasonable expectation of making significant functional improvement and returning to the community.

The skilled nursing facility (SNF) level of care only requires 1.5 hours of therapy per day, as well as a skilled need (such as rehabilitation therapy). Long-term care hospitals, formerly called long-term acute care, require a 30-day hospitalization. Outpatient therapy is typically provided 3 times per week. Approximately 30% of stroke survivors received outpatient rehabilitation in a population-based analysis from the Centers for Disease Control and Prevention.¹³⁰ This can vary from single discipline, for example, just physical therapy, to a comprehensive team approach. Outpatient therapy can occur in hospital-based programs, physician offices, and other settings.

Home health services require a medical need for skilled services and physician attestation that the patient is homebound. CMS recently issued regulations, effective January 1, 2011, as mandated under the federal Affordable Care Act, that the physician or other licensed independent practitioner (eg, nurse practitioner, clinical nurse specialist, physician assistant) document the primary reason that the patient requires home health services and must certify that his or her clinical findings support that this patient is homebound (ie, absences from home require considerable and taxing effort when the absences are for medical reasons or religious services, or the absences from home are infrequent or of short duration) based on a face-to-face encounter with the patient.

Typical lengths of stay are shorter for IRF/acute rehabilitation and longer for SNFs. The average length of stay in IRFs for stroke patients was 16.5 days in 2008, continuing a gradual downward trend from 19.6 days in 2000,¹³¹ accompanied by a rise in discharges from the IRF to acute care (4.0% in 2000 to 7.5% in 2008) and to long-term care hospitals (5.6% in 2000 to 10.3% in 2008). These data are based on 635 105 patients over the 8-year period who were diagnosed with a stroke and then admitted to 1 of 893 medical rehabilitation facilities, either a hospital-based unit or a free-standing rehabilitation hospital, and reported to the Uniform Data System for Medical Rehabilitation, a not-for-profit organization affiliated with the State University of New York at Buffalo.¹³¹

Institutional Payment System for IRF and SNF

IRFs have been reimbursed for Medicare patients under a prospective payment system since 2002. The level of reimbursement is determined by a complex algorithm that

includes the primary rehabilitation diagnosis, the age of the patient, the degree of motor impairment as measured by the functional independence measure, and selected comorbidities that determine 1 of 4 “tiers” of payment. Tiers are determined by comorbidities; however, not all comorbidities count toward the tier status, and the same comorbidity will apply to one diagnosis but not another. For example, dysphagia does not “count” toward stroke (where it is an expected or common accompaniment), but it does count in a spinal cord injury diagnosis.

Patients with stroke are classified into 1 of 10 case-mix groups based on the level of functional impairment as measured by the motor score on the functional independence measure, cognitive functional independence measure score, and patient age. There are adjustments related to facility-level factors such as rural versus urban, teaching status, and low-income percentage, as well as adjustments under the Affordable Care Act and wage and labor-related market adjustments, which finally yields a standard payment conversion factor (Table 6).

Based on the fiscal year 2010 adjusted RPL (rehabilitation, psychiatric, and long-term care hospital) market basket, the standard payment conversion factor is ≈\$13 627. This is multiplied by the relative weight to obtain the institutional payment. The average length of stay is calculated and serves as a near proxy for payment. Many HMOs (health maintenance organizations) pay rehabilitation facilities based on negotiated per diem rates, and a few payers base the payment on hospital charges or discounted hospital charges. Physician payment from Medicare is identical to inpatient acute hospital charges.

SNFs are reimbursed on a per diem basis using case-mix groups called resource utilization groups. Categories for

resource utilization groups are based on staff time measurement data. Patients are classified into categories for resource utilization groups using data from the Minimum Data Set collected by the facility staff. SNFs are required to complete the Minimum Data Set on the 5th, 14th, 30th, and 60th days after admission.

Various Factors That Impact the Use of Postacute Care

Older stroke patients in Medicare HMOs are less likely to be discharged to IRFs than Medicare fee-for-service patients.¹³³ Prospective payment systems play a significant role in determining where Medicare patients with stroke, hip fracture, or lower-extremity joint replacement receive their postacute care.¹³⁴

After SNF-prospective payment system implementation, significant reductions in the intensity and duration of physical and occupational therapy in Medicare fee-for-service patients have occurred.¹³⁵ There is geographic variation in the provision of postacute care to Medicare patients in general, not specifically stroke patients, likely the result of practice styles, the supply or access to services, and local regulatory practices.¹³⁶ Geographic proximity, number of facilities, and hospitals with related IRF or related SNFs are all factors that influence the likelihood of use of services.¹³⁷

Policy Recommendation

1. A stroke system of care should ensure that all patients have access to poststroke care (ie, discharge planning services, rehabilitation, nursing facilities, medical follow-up) regardless of their financial status or socioeconomic background. Such availability will ensure that each patient has the opportunity to achieve

Table 6. Average Length of Stay for the 10 Case-Mix Groups for Ischemic Stroke¹³²

CMG	CMG	Relative Weight				Average Length of Stay, d			
		Tier 1	Tier 2	Tier 3	None	Tier 1	Tier 2	Tier 3	None
0101	Stroke M >51.05	0.7676	0.7182	0.6451	0.6102	10	10	9	8
0102	Stroke M >44.45 and M <51.05 and C >18.5	0.9527	0.8913	0.8007	0.7573	12	13	10	10
0103	Stroke M >44.45 and M <51.05 and C <18.5	1.1377	1.0644	0.9562	0.9043	14	14	12	12
0104	Stroke M >38.85 and M <44.45	1.1819	1.1058	0.9934	0.9395	15	14	13	12
0105	Stroke M >34.25 and M <38.85	1.3733	1.2849	1.1542	1.0916	16	17	14	14
0106	Stroke M >30.05 and M <34.25	1.5815	1.4796	1.3291	1.2571	20	18	16	16
0107	Stroke M >26.15 and M <30.05	1.7906	1.6753	1.5049	1.4233	20	20	18	18
0108	Stroke M <26.15 and A >84.5	2.2178	2.0749	1.8639	1.7629	31	25	23	22
0109	Stroke M >22.35 and M <26.15 and A <84.5	2.0508	1.9188	1.7236	1.6302	24	23	20	20
0110	Stroke M <22.35 and A <84.5	2.6434	2.4731	2.2216	2.1012	33	29	26	25

A indicates age (in years); C, cognitive score from functional independence measure; CMG, case-mix group; and M, motor score from functional independence measure.

a maximum recovery from stroke, which will ultimately reduce the societal and economic impact of stroke.

Summary

In many cases, patients having an acute stroke will enter the medical care system in a very disabled and dependent state, unable to make cogent medical care decisions on their own behalf. Family members are often unfamiliar with stroke as a disease and are not in a good position to make rapid and well-informed decisions about acute care. Because of these circumstances, it is incumbent on any stroke system of care to ensure that all patients receive the most efficient and rapid care, regardless of how they first enter or access the medical care system.

A seamless and ideal stroke system of care that spans the various components from calling 9–1–1 through rehabilitation has been presented. Although it is recognized that certain care paradigms will vary because of local and regional factors, protocols, and limitations, certain aspects of this system of care are mandatory. These include the rapid identification of patients with an acute stroke; the proper triage of such patients to the facility that will provide them with the most appropriate level of care; in-hospital care that is consistent with current

guidelines; ongoing quality improvement efforts; and comprehensive rehabilitation efforts on discharge. Telemedicine and related technologies will play a key role in exporting the expertise of a PSC or CSC to outlying or remote hospitals. Benchmarks for evaluating the quality of care throughout the spectrum of a stroke system of care should be implemented.

Both local and regional healthcare providers, as well as government officials and related agencies, should adopt many of the procedures and policies cited in this document (Table 7). Although some modifications may be needed because of local and geographic issues, the final system should be structured to ensure that the care pathways and paradigms are seamless, efficient, and consistent with current medical guidelines. Coordination between and among the various components of a stroke system is perhaps the most challenging but most essential aspect of any system of care, because it spans usual lines of demarcation for medical care and government jurisdiction as we now define it.

Multiple studies show that “time is brain,” and a stroke system of care should strive to reduce any time delays. With this in mind, any system of care will only be as strong and efficient as its weakest link. We hope to minimize or eliminate any weak links by following the principles outlined in this document. Our patients are counting on us.

Table 7. Summary of Policy Recommendations

1. Public health leaders along with medical professionals and others should design and implement public education programs focused on stroke systems and the need to seek emergency care (by calling 9–1–1) in a rapid manner. These programs should be repetitive and designed to reach diverse populations.
 - 1a. EMS leaders in coordination with local, regional, and state agencies and in consultation with medical authorities and local experts should develop triage paradigms and protocols that ensure that all patients with a known or suspected stroke are rapidly identified and assessed by use of a validated and standardized instrument for stroke screening, such as the FAST scale, LAPSS, or CPSS.
2. Unless there are compelling mitigating circumstances, when there are several acceptable hospitals in a well-defined geographic region, extra transportation times to reach another facility should be limited to no more than 15 to 20 minutes. When several hospital options exist, EMS should seek care at the facility capable of offering the highest level of stroke care.
 - 2a. Protocols that include prehospital EMS notification that a stroke patient is en route should be used routinely.
3. Healthcare authorities, medical leaders, and government agencies should support the formation, operations, and certification of stroke centers as one proven means to improve patient care and outcomes. These stroke centers should publicly report their performance and outcomes.
4. Different services within a hospital that may be transferring patients through a continuum of care, as well as different hospitals that may be transferring patients to other facilities, should establish hand-off and transfer protocols and procedures that ensure safe and efficient patient care within and between facilities.
 - 4a. Protocols for interhospital transfer of patients should be established and approved beforehand so that efficient patient transfers can be accomplished at all hours of the day and night.
5. All hospitals caring for stroke patients within a stroke system of care should develop, adopt, and adhere to care protocols that reflect current care guidelines as established by national and international professional organizations and state and federal agencies and laws.
6. Because of the limited distribution and availability of neurological, neurosurgical, and radiological expertise, the use of telemedicine/telestroke resources and systems should be supported by healthcare institutions, governments, payers, and vendors as one method to ensure adequate 24/7 coverage and care of stroke patients in a variety of settings.
7. Cities, counties, regions, and states are urged to develop an organizational infrastructure and decision-making body to assist in addressing care issues, decision making, implementation, and problem solving. This is typically in the form of a stroke committee defined by a region or other overseeing body.
 - 7a. All of the elements of a stroke system of care will operate in a highly complex and multidisciplinary environment with many elements and stakeholders, each with their own rules and regulations. In terms of the many controlling authorities, it is paramount that the “best interests of the patient” be the primary concern and driving factor when any rules and regulations are made and implemented.
8. Government agencies and third-party payers are urged to develop and implement reimbursement schedules for patients with acute stroke that reflect the demanding care and expertise that such patients require to achieve an optimal outcome, regardless of whether they receive a specific medication or procedure.
9. Each major element of a stroke system of care, as well as the entire system as defined by local regional factors, should develop and implement at least 2 meaningful quality improvement projects that will result in improved patient care or outcomes.
 - 9a. Stroke outcome measures must include adjustments for baseline severity.
10. A stroke system of care should ensure that all patients have access to poststroke care (ie, discharge planning services, rehabilitation, nursing facilities, medical follow-up) regardless of their financial status or socioeconomic background. Such availability will ensure that each patient has the opportunity to achieve a maximum recovery from stroke, which will ultimately reduce the societal and economic impact of stroke.

CPSS indicates Cincinnati Prehospital Stroke Scale; EMS, emergency medical services; FAST, facial droop, arm drift, speech problems (test); LAPSS, Los Angeles Prehospital Stroke Screen; and 24/7, 24 hours per day, 7 days per week.

Disclosures

Writing Group Disclosures

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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (1) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (2) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

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This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers are required to complete and submit. A relationship is considered to be "significant" if (1) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (2) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Significant.

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KEY WORDS: AHA Scientific Statements ■ acute stroke-ready hospitals ■ comprehensive stroke centers ■ primary stroke centers ■ stroke ■ stroke centers ■ stroke systems of care