Recommendations for the Establishment of Stroke Systems of Care

Recommendations From the American Stroke Association's Task Force on the Development of Stroke Systems

Task Force Members

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Stroke continues to be a significant cause of morbidity and mortality in the United States. Approximately 700 000 Americans have a new or recurrent stroke each year, and stroke remains the third leading cause of death in the United States when considered independently from other cardiovascular diseases. Stroke also remains a leading cause of serious, long-term disability in the United States.[1]

Major advances have been made during the past several decades in stroke prevention, treatment, and rehabilitation. Despite successes in delivering effective new therapies, significant obstacles remain in ensuring that scientific advances are consistently translated into clinical practice. In many instances, these obstacles can be related to a fragmentation of stroke-related care caused by inadequate integration of the various facilities, agencies, and professionals that should closely collaborate in providing stroke care. There is increased emphasis on improving the components of stroke care, including recommendations from the Brain Attack Coalition for primary stroke centers and a formal process provided through the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) for the certification of primary stroke centers.[2–4] It is critically important to look carefully at how the distinct components can be better integrated into systems of stroke care.

The American Stroke Association (ASA), a division of the American Heart Association (AHA), is dedicated to improving stroke prevention, treatment, and rehabilitation through research, education, advocacy, and the development and application of scientifically based standards and guidelines. The ASA convened a multidisciplinary group, the Task Force on the Development of Stroke Systems, to describe the current fragmentation of stroke care, to define the key components of a stroke system, and to recommend methods for encouraging the implementation of stroke systems. The term "stroke system" is used in this article to avoid the corporate and financial connotations associated with the words "network" and "in-network," although the term "stroke network" could otherwise be used interchangeably with "stroke system."

The Task Force was responsible for developing recommendations on the organization and operation of systems of care for the treatment of stroke patients throughout the United States, including both ischemic and hemorrhagic subtypes (intracerebral hemorrhage, ICH; subarachnoid hemorrhage, SAH; and intraventricular hemorrhage, IVH). These recommendations are not intended to impose any particular treatment strategies for stroke on individual providers.

The Task Force comprised nationally recognized experts in the areas of stroke prevention, emergency medical services, acute stroke treatment, stroke rehabilitation, and health policy development. Under the direction of the Task Force, ASA/AHA staff and HealthPolicy R&D (a health policy firm in Washington, DC, affiliated with the law firm Powell, Goldstein, Frazer & Murphy, LLP) conducted a comprehensive review of the relevant clinical stroke literature.

The review of the medical literature included the use of Medline searches for articles published between January

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This policy recommendation also appears in the March 1, 2005 issue of *Circulation* (available online at http://www.circ.ahajournals.org).

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(*Stroke*. 2005;36:690-703.)

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***Stroke* is available at http://www.strokeaha.org** **DOI: 10.1161/01.STR.0000158165.42884.4F**

1994 and December 2003 to identify studies relevant to the treatment of stroke and the establishment of stroke systems. A range of search terms* identified >1000 articles of potential interest, and a review of these primary articles generated additional references, as did Task Force members. Task Force members participated in a series of teleconferences to draft the content of these recommendations.

Building Stroke Systems of Care

A Systems Approach for Stroke

The Institute of Medicine (IOM) of the National Academy of Science has concluded that the fragmentation of the delivery of healthcare services frequently results in suboptimal treatment, safety concerns, and inefficient use of healthcare resources. To ensure that scientific knowledge is translated into practice, the IOM has recommended the establishment of coordinated systems of care that integrate preventive and treatment services and promote patient access to evidence-based care.[5]

In general, the fragmented approach to stroke care that exists in most regions of the United States fails to provide an effective integrated system for stroke prevention, treatment, and rehabilitation because of inadequate linkages and coordination among the fundamental components of stroke care. Although individual components of a stroke system may be well developed, these components often operate in isolation. The problem of access to coordinated stroke care may be exacerbated in rural or neurologically underserved (inadequate access to neurological expertise) areas.

A stroke system should coordinate and promote patient access to the full range of activities and services associated with stroke prevention, treatment, and rehabilitation, including the following key components:

- Primordial and primary prevention (defined below)
- Community education
- Notification and response of emergency medical services
- Acute stroke treatment, including the hyperacute and emergency department phases
- Subacute stroke treatment and secondary prevention
- Rehabilitation
- Continuous quality improvement (CQI) activities

States and Local Communities Pursuing Incremental Approaches to Stroke System Development

In 2002, a task force sponsored by the National Institute of Neurological Disorders and Stroke (NINDS) within the National Institutes of Health published recommendations calling for greater coordination and better support mechanisms for the various components and professionals involved in both prehospital and acute hospital stroke care.[6] This need to foster the development of stroke systems at the state and local levels is reflected in a resolution recently passed by the US House of Representatives.[7]

Some regions and states in the United States have made forays into establishing stroke systems, often adopting an initial approach that focuses on the acute aspects of stroke treatment. The NINDS-sponsored task force highlighted initial efforts to establish stroke systems for acute care in a number of regions around the country, including Houston, Tex; Cincinnati, Ohio; Dallas, Tex; Ann Arbor, Mich; Birmingham, Ala; and Morgantown, WV.[6,8,9] There are also reports of systems to provide stroke care in rural Georgia and parts of Canada.[10,11]

Methods for coordinating resources and quality improvement programs among hospitals to reduce complications and improve access to high-quality stroke care have been demonstrated in several communities and regions. Investigators in North Carolina found that expanding the scope of stroke care services in a targeted, coordinated manner at just 6 hospitals could help improve access to basic acute stroke services from 52% to 84% of North Carolina's residents.[12] In addition, a group of hospitals in Cleveland, Ohio, collaborated in a quality improvement program that reduced the rate of complications associated with the administration of thrombolytic therapy for acute stroke.[13,14]

Resources and Costs

In some instances, it may be practical from the outset to design a comprehensive stroke care system that addresses the full range of required components. In other instances, resource constraints and other concerns may necessitate an incremental approach initially focusing on a more limited scope of services. Incremental efforts should be designed to promote the evolution of a stroke system into one that ultimately addresses the full range of stroke prevention, treatment, and rehabilitation.

The costs associated with establishing stroke systems could present obstacles for implementation, although stroke systems that improve the delivery of proven therapies are likely to have a positive impact on public health at a cost that society generally accepts as favorable and may offset some costs. Many proven therapies are highly cost-effective, with some producing cost savings.[15,16] In addition to the potential to improve patient outcomes, the costs associated with implementing an effective stroke system may be offset, at least in part, by the potential cost savings realized by individual hospitals and facilities. As stroke systems begin to develop, further research examining the relationships among costs and various patient outcome measures is needed. In addition, the proliferation of stroke systems would be facilitated by balancing the differential between the system components in which most costs are incurred versus the components in which the most fiscal benefit for high-quality care is enjoyed.

*Search terms included ("patient education" or "public education" or "public service announcement" or "PSA") within 50 words of "stroke"; ("EMS" or "emergency medical service") within 50 words of "stroke"; ("disease management" or "case management") within 50 words of "stroke"; ("post-acute care" or "rehab!") within 10 words of "stroke"; "interventional radiology" within 50 words of "stroke"; ("physician awareness" or "physician education" or "continuing medical education" or "CME") within 50 words of "stroke"; "telemedicine" within 50 words of "stroke"; ("cost effective!" or "cost benefit analysis") within 10 words of "stroke"; ("tPA" or "tissue plasminogen activator") and "stroke"; "secondary prevent!" and "stroke"; ("acute hospital" or "acute prehospital") and "stroke"; and ("primary prevention" or "community awareness") and "stroke."

Application of Systems Approaches to Other Emergency Conditions

The trauma care system is guided by principles that are applicable to improving stroke care, including enhanced communication among hospitals and emergency medical services (EMS), clear transport protocols to ensure that patients are taken only to facilities with appropriate resources, strategies for treating and transporting patients who live in rural and remote areas, integration of rehabilitation services, and the use of evidence-based treatment protocols. Local and regional trauma systems are effective in decreasing trauma-related morbidity and mortality.[17–27]

Despite being based on similar principles, a number of important differences exist between the organization of trauma care and that of stroke care. These differences are such that simply designating trauma systems as stroke systems would be inappropriate. The medical personnel involved in the evaluation and treatment of stroke and trauma differ. Primary stroke centers are less resource intensive to establish than are level I trauma centers. Because of the nature of stroke, virtually all facilities will continue to evaluate and treat stroke patients, and the identification of hospitals that function as primary stroke centers within stroke systems should be as inclusive as possible. Primary stroke centers certainly should be more numerous than level I trauma centers.

General Recommendations for the Implementation and Establishment of Stroke Systems of Care

Although no single set of characteristics defines a healthcare system, a hallmark of the systems approach is the promotion of communication and collaboration among the various patients, providers, and facilities. The US Health Resources and Services Administration defines a healthcare system as including 2 fundamental elements: (1) the agencies, services, and providers involved in providing medical care to individual members of a community and (2) the interactions among these agencies, services, and providers.[28]

In setting forth recommendations for the establishment of stroke support systems, the NINDS task force also emphasized the need to link and coordinate the activities of providers, concluding that a stroke system should fundamentally be a single entity that is responsible for organizing the stroke system and should have the ability to cross geopolitical lines and coordinate all participants through emergency response call centers (eg, 9-1-1) and EMS agencies.[6]

Various forms of telemedicine (ranging from forms as technologically straightforward as a simple telephone conversation to as advanced as videoconferencing) and transport services can facilitate the linkages among providers throughout a stroke system, especially in rural areas.[6,29] In addition, forms such as teleradiology can enable the rapid review of CT scans and other imaging data by offsite radiologists, neurologists, or other stroke experts in the context of hyperacute stroke care.[30–32] The development of transport programs, including air transportation, when appropriate, provides an important tool to expedite patient transport and to enable distant facilities to collaborate in the care of stroke patients.[33–35]

The ASA's Task Force on the Development of Stroke Systems makes the following general recommendations on the development of stroke care systems:

1. **A stroke system should serve 3 critical functions.** First, a stroke system should ensure effective interaction and collaboration among the agencies, services, and people involved in providing prevention and the timely identification, transport, treatment, and rehabilitation of individual stroke patients in a locality or region. Second, a stroke system should promote the use of an organized, standardized approach in each facility and component of the system. Third, a stroke system should identify performance measures (both process and outcomes measures) and include a mechanism for evaluating effectiveness through which the entire system and its individual components continue to evolve and improve.
2. **A stroke system should provide both patients and providers with the tools necessary to promote effective stroke prevention, treatment, and rehabilitation.** Effective stroke care requires coordination of the activities and resources of a broad range of individuals, facilities, and organizations. Ultimately, a stroke system should coordinate activities and resources to ensure that the appropriate patients are receiving care from the appropriate providers in the appropriate amount of time.
3. **A stroke system should ensure that decisions about protocols and patient care are based on what is in the best interests of stroke patients.** Participants in a stroke system should work scrupulously to ensure that the best interests of stroke patients are considered first and foremost above those of geopolitical boundaries or corporate affiliations. Such consideration may require collaboration among entities in neighboring states or political jurisdictions. Factors such as the location of needed referral facilities, the areas served by individual EMS programs, and the areas served by local and state agencies could affect the appropriate size of individual stroke systems.
4. **A stroke system should identify and address potential obstacles to successful implementation.** Potential obstacles to the establishment of stroke systems include the costs of developing and maintaining a stroke system, geopolitical lines of service by EMS, adequate legal and political recognition of the system, competition for patients and market share among providers, tensions that may exist among academic and community-based institutions, variable commitment to acute stroke therapy, differences in corporate culture among different facilities and provider groups, and concerns about the adequacy of reimbursement. To address such issues, a stroke system should recognize the important and distinct roles to be played by policymakers and stakeholders at various levels, including federal, state, regional, local, and institution-based officials.
5. **Stroke systems should be customized for each state, region, or locality, although certain universal elements are encouraged to help ensure optimal prevention and the timely identification, transport, treatment, and rehabilitation of stroke patients.** Many important issues should be addressed at the local level, such as the organization, leadership, and governance structure established for the stroke system. A local or regional systems

approach is critical in part because rural and neurologically underserved areas may require collaboration with other stroke system members to ensure access to all of the core components of a primary stroke center, as well as access to the broader services that are required to provide stroke patients with the most appropriate treatments. In many instances, telemedicine, ground transport, or air transport may help facilitate the links critical to establishing a meaningful system for stroke prevention, treatment, and rehabilitation.

Component-Specific Recommendations for the Implementation and Establishment of Stroke Systems of Care

Primordial and Primary Prevention

Primordial prevention refers to strategies designed to decrease the development of disease risk factors (eg, efforts to decrease the development of obesity, increase exercise, and provide a well-balanced diet). Thus, primordial prevention encompasses the entire population and is not limited to individuals with recognized risk factors for stroke or other cardiovascular diseases. General prevention efforts that target smoking cessation, obesity, and diabetes may benefit the entire population. For prevention efforts that have broad impacts on health, such as reductions in diseases other than stroke, partnerships with other stakeholders may strengthen efforts by increasing policy support and resources.[36]

Primary prevention refers to the treatment of established disease risk factors. Much is known about the regimens and therapies that are successful in preventing the vast majority of strokes, including the management of hypertension, lipid levels, diabetes, atrial fibrillation, and other modifiable risk factors.[37–41] Disease management and medication adherence strategies may help promote the implementation of primary prevention regimens.[42]

The relatively low rates of long-term adherence to these primary prevention guidelines also are widely known. The underlying obstacles to implementing evidence-based guidelines are multifactorial, including failures in public and provider education and inadequate support mechanisms to aid both patients and providers in initiating and maintaining prevention strategies.[6] For example, hypertension is a long-recognized risk factor for stroke. In the population of adults with hypertension, ≈30% are unaware of their hypertension, ≈25% are receiving treatment for hypertension but are inadequately controlled, and only 34% are adequately controlled.[43]

Community-based programs can improve primary prevention.[44–46] Under the Medicare program, data collected by what once were called peer review organizations, now renamed quality improvement organizations, evaluated the rates at which stroke patients were prescribed appropriate preventive therapies. The improvements reported over time in these data suggest that organized, standardized approaches to preventive care for stroke can increase the rates at which appropriate therapies are initiated.[47]

Initiatives to enhance primordial and primary prevention are related to the secondary prevention strategies that should be initiated after the occurrence of a stroke or other cardiovascular event (see Subacute Stroke Care and Secondary Prevention for Stroke). Such efforts include the use of anticoagulants in patients with atrial fibrillation, use of antithrombotic medications, and appropriate use of antihypertensive and lipid-altering medications.[48–51]

The Task Force makes the following recommendations in the context of primordial and primary prevention for stroke:

1. **A stroke system should develop support mechanisms to assist communities and providers in initiating prevention regimens applicable to the population as a whole.** A stroke system should emphasize support tools and measures designed to enhance provider awareness of stroke prevention strategies and current evidence-based treatment recommendations. Providers should be encouraged and assisted in initiating primordial and primary prevention strategies and in putting in place referral plans that conform to recognized stroke treatment recommendations. Communities are encouraged to use all available resources to ensure optimal stroke care, and public policy initiatives should support such efforts.
2. **A stroke system should develop support tools to assist the population as a whole, patients, and providers in long-term adherence to primordial and primary preventive treatment regimens.** Comprehensive support mechanisms should employ multiple strategies that target both providers and patients, and these strategies should take into consideration cultural and geographic customs. Education and practice tools should be developed with health literacy targets appropriate to the linguistic needs and education levels of the targeted population. These tools should be designed to support providers in monitoring current stroke prevention recommendations. Useful support tools may include disease management programs and medication adherence interventions.

Community Education

Despite numerous efforts to increase awareness, overall knowledge among the public remains poor with regard to stroke risk factors, the signs and symptoms of stroke, and the availability of a time-sensitive therapy, especially among groups at the highest risk for stroke.[52–60] Improving the public's knowledge of the risk factors, signs, and symptoms of stroke is critical to improving the quality of stroke care. Without organized, coordinated approaches to educate the public that take into account a host of local issues, the full potential of proven therapies for prevention or acute intervention will not be realized.

Increased awareness of the risk factors and common warning signs of stroke may increase the appropriate use of emergency response numbers such as 9-1-1, resulting in timely presentation to the emergency department.[54,61,62] Early presentation increases the proportion of patients eligible for new acute stroke treatments that must be administered soon after stroke onset.[52,55,63–65] Increased public knowledge of stroke risk factors also enhances the likelihood that patients will seek and adhere to risk-reduction regimens[52,57,65,66] (see discussions of prevention in Primordial and Primary Prevention and Subacute Stroke Care and Secondary Prevention for Stroke).

Public education should be directed at both those at risk for stroke and their families, including children.[52–54,56–58,67,68] A number of methods have been evaluated to promote public education and primary prevention. For example, mass media and television campaigns, as well as multifaceted approaches that target caregivers in addition to the public, have been credited with increasing public awareness and knowledge of stroke risk factors and warning signs.[9,52,54,57,61,64,65,67,69–76]

The Task Force makes the following recommendations in the context of community education for stroke:

1. **A stroke system should support educational programs that target high-risk populations and their families.** Community education initiatives should target older adults, patients with atrial fibrillation, patients with previous stroke or transient ischemic attack (TIA), and other vulnerable populations (eg, certain racial, ethnic, and socioeconomic groups) so that these high-risk populations and their immediate families are particularly aware of the causes, signs, and symptoms of stroke. It is critical that most, if not all, high-risk individuals and likely bystanders recognize the signs and symptoms of stroke, as well as the need to call emergency response telephone numbers.
2. **A stroke system should ensure that educational efforts include community-based organizations, policymakers, and other stakeholders.** Community-based organizations provide an important avenue for achieving the educational goals of the stroke system. Community-based organizations can help sponsor and promote educational efforts in ways that may be especially effective in communicating with local communities, including reaching ethnic and racial minorities. Within a stroke system, the relevant local and national policymakers also should be educated about the need for an effective stroke system in the community and specific ways in which local, state, and national policymakers can best support the patients who are served by the system.

Notification and Response of EMS for Stroke

The effective notification and response of EMS for stroke involves a complex interaction among the public, the applicable EMS programs, and the relevant hospital emergency departments.[77] Stroke patients or a bystander witnessing a stroke must recognize the signs and symptoms of stroke and the importance of calling an emergency response telephone number immediately to help initiate effective therapy as rapidly as possible.[78–80]

EMS operators and dispatchers play a critical role in recognizing stroke and determining the timing and type of the EMS response to stroke. A systems approach can help implement measures that decrease the time from receipt of a call for a probable stroke to the dispatch of EMS personnel. In the absence of ongoing stroke-specific training and feedback, EMS operators and dispatchers may fail to identify a significant percentage of potential strokes,[81,82] even when callers spontaneously use the word "stroke" in communicating with the dispatcher.[83]

Establishing programs that provide ongoing education for field EMS personnel to facilitate the accurate and rapid recognition of patients with acute strokes is essential to promote making appropriate decisions involving the treatment, transport, and destination of patients suspected of having a stroke.[74,84–87] Although EMS responders frequently fail to identify strokes when support mechanisms are not in place, stroke-recognition tools have been developed that assist EMS personnel in identifying patients with acute cerebral ischemia and intracranial hemorrhage with high sensitivity and specificity.[88–90]

Recognition of stroke by EMS personnel is needed to guide both the transportation of patients to the most appropriate facilities and the initiation of stroke-specific basic or advanced life support before the patient's arrival at the hospital.[82,86,87,91,92] Effective communication between EMS responders and receiving emergency departments is important in optimizing the efficiency of the hospital's response to acute stroke. Time is saved when notification from EMS enables the emergency department to begin assembling the personnel necessary to treat an acute stroke patient.[93,94] EMS responders and communicators also can play an important role in collecting information about the time of the onset of stroke symptoms. Such data can be essential to clinical decision making in the acute treatment of stroke.

There are potential benefits from coordinating air transport options with EMS to enhance stroke care. The use of helicopter-based transportation offers the potential to expand access to stroke therapies and services that are not widely available to patients in some rural and other neurologically underserved areas. When initiated quickly as part of a collaborative interfacility system, helicopter-based transportation can reduce the time to emergency department arrival at hospitals that are equipped to treat acute stroke patients.[33,35,95]

The Task Force makes the following recommendations in the context of notification and response of EMS for stroke:

1. **A stroke system should include processes that provide rapid access to EMS for patients with acute stroke and that dispatch EMS in the shortest time possible, given local resource availability.** The public should have ready access to EMS through an emergency number program that matches the caller's need with the available resources, including the use of universal enhanced 9-1-1 (E911) or a standard number that is accessible through both landline and wireless telephones. People experiencing acute strokes may be unable to describe their location to EMS communicators, and as a result, there is a need for automatic caller location and number identification (eg, E911). The nearest appropriate EMS response unit should be dispatched immediately. Each stroke system should develop goals for the time period between the receipt of the call to the emergency response number and the dispatch of the response team, and the stroke system should monitor adherence to these goals and implement process changes as needed.
2. **A stroke system should promote the use of diagnostic algorithms and protocols by EMS dispatchers that reflect the most current stroke treatment recommendations and should dispatch EMS responders for suspected strokes with the most rapid emergency response and within the same time limits/goals established for other acute events (eg, myocardial infarction [heart attack] and trauma).** Stroke education materials, such as stroke guide cards, should be available to assist EMS communicators in recognizing the signs of stroke. EMS responders should use validated scales (eg, Cincinnati's, Los Angeles', or similar scales that may be developed) to aid the rapid and accurate identification of stroke patients. Each local or regional EMS component of a stroke system

should determine goal response times for suspected stroke patients that are tailored to that region's resources and infrastructure. These decisions should balance the availability of different level responders (eg, basic life support versus advanced life support) and the need for rapid transport to an appropriate hospital.

3. **A stroke system should ensure the direct involvement of emergency physicians and stroke experts in the development of stroke education materials, communications and field assessment protocols, treatment protocols, and transport protocols for EMS providers. Such training and protocols should focus on stroke recognition, triage/transport decisions, and early notification to the receiving hospital.** Frequent and meaningful dialogue should take place among prehospital providers, emergency department directors, and stroke center directors about operational issues and collaborative educational efforts. The stroke system should determine and then deliver the initial and continuing education needed to provide optimal patient care.
4. **A stroke system should ensure that all patients having signs or symptoms of stroke be transported to the nearest primary stroke center or hospital with an equivalent designation, given the available acute therapeutic interventions. Air transport should be considered to shorten the time to treatment, if appropriate. Stroke patients who are not candidates for hyperacute interventions should be evaluated at the closest hospital and considered for transfer, if appropriate, to a primary stroke center or other facility through established referral processes.** All available EMS transportation resources, including ground and air transport, should be considered to minimize transport time to the appropriate hospital. If no primary stroke center hospital is available within an appropriate time frame for available therapeutic interventions, then stroke patients should be transported to the closest hospital with a physician-staffed emergency department. Hospitals lacking the resources to provide primary stroke care, as defined in the Brain Attack Coalition's recommendations for primary stroke centers, should enter into pre-event-negotiated transfer agreements with hospitals possessing such capabilities. If such a hospital is unavailable or beyond a reasonable transport time, then alternative plans should be in place for transport to the hospital that is best prepared for triaging and emergently treating stroke patients in that geographic area. Stroke transport protocols should be based on providing the highest possible quality of clinical care and reducing transport times. Hospital or corporate affiliations, as well as local and state boundaries, should not interfere with the safe and efficient care and transport of stroke patients.
5. **A stroke system should ensure that EMS personnel perform and document agreed-upon stroke patient assessments and screening of candidates for thrombolysis or other hyperacute interventions, as such interventions become available.** All potential stroke patients should be scored and screened for stroke signs and symptoms, time of onset, and contraindications to thrombolytic therapy or other hyperacute therapies that may become available through the completion of forms or other methods (as agreed on by the local stroke community in collaboration with EMS) to provide written or transmitted data to the receiving hospital. Obtaining this information should not delay patient transport. The scoring and screening tools should be part of a comprehensive quality improvement program and be improved and refined as needed.

Acute Treatment for Stroke

One critical element of the multidisciplinary stroke system is the hospital-based acute stroke team. This is the component of the stroke system that is prepared to handle the hyperacute phase of diagnosis and treatment of acute stroke events. The availability of providers capable of diagnosing and treating all aspects of acute stroke remains critical. The composition and responsibilities of the team will vary as appropriate for specific facilities.

The use of acute stroke teams improves stroke care and increases the appropriate use of stroke therapies through established protocols. Acute stroke teams facilitate the rapid evaluation and treatment of acute stroke patients that result in improved patient outcomes, whereas the lack of acute stroke teams is associated with less frequent use of known effective stroke therapies and may compromise stroke care.[8,13,14,96–101]

Acute stroke teams help to coordinate stroke care from the moment the patient arrives at the emergency department or after notification from prehospital personnel. Rapid identification of acute stroke patients enables the early administration of effective and appropriate stroke therapies.[3,102–110] Providers who triage potential stroke patients should be trained to identify acute stroke symptoms.[4,8,97,99,111–113] Such a provider might be a physician, nurse, or other type of physician extender, if appropriate training and treatment protocols have been implemented.

For selected patients with ischemic stroke, intravenous tissue plasminogen activator (tPA) is an effective therapy[114,115]; however, intravenous tPA is used infrequently. A common reason cited for the low level of use of thrombolytic therapy for acute ischemic stroke is the lack of adequate support mechanisms for physicians who might otherwise prescribe it if adequate consultative services were more readily available.[6,116] Also, identification of acute stroke patients often occurs too late for the effective administration of intravenous tPA.[9,13,116–123] Wide variability exists among the approaches used in various communities and the percentages of acute ischemic stroke patients that receive thrombolytics.[8,124,125] In hospitals with established protocols for the rapid identification and treatment of ischemic stroke patients, the rates of intravenous tPA use have increased, whereas protocol deviations have decreased.[14,29,126–128]

A systems approach that provides timely multidisciplinary care also is needed to treat patients with various forms of hemorrhagic stroke, including SAH, ICH, and IVH. Improved patient outcomes are associated with the acute detection and treatment of SAH, including early management of blood pressure.[129–131] New therapies may become available in the future. Mortality and the degree of disability are reduced in SAH by ≈25% in hospitals that can provide specialized treatment.[132,133] Early detection also is important in the treatment of ICH and IVH when coupled with surgical intervention for posterior fossa ICH[130] and drainage of IVH[134] when indicated.

The acute care phase also is a critical period for initiating and coordinating strategies embodied in protocols and clinical pathways to prevent stroke progression, recurrent stroke,

and common complications (see Subacute Care and Secondary Prevention for Stroke).

Acute stroke interventions may be extended to patients in rural and neurologically underserved areas by establishing consultation and patient transfer protocols.[34,135,136] Rapid evaluation, referral, and transfer may be established through the application of stroke care protocols.[137] The protocols should include participation by EMS personnel who are called on to provide interfacility transport of patients to appropriate stroke care facilities and support the transport of patients who may receive an infusion of intravenous tPA initiated at the referring hospital.

The Task Force makes the following recommendations in the context of the acute treatment of stroke:

1. **A stroke system should determine the acute stroke treatment capabilities and limitations of all hospitals and make these available to primary care providers, EMS, and the public.** Any hospital in the stroke system that provides emergency department services should be able to function as a primary stroke center or rapidly transfer appropriate patients through the use of prenegotiated interhospital protocols and transfer agreements and transport protocols. Suspected stroke patients should receive timely acute primary stroke care at any hospital in the stroke system, according to a prespecified care plan.
2. **A stroke system must develop strategies that incorporate hospitals that do not intend to seek stroke center status. All hospitals and facilities that could be involved in the care of acute stroke patients should develop action plans for the triage and treatment (or transport) of stroke patients.** Noncertified hospitals and other facilities should have predetermined plans to collaborate with other facilities (eg, via telemedicine or transport protocols) to ensure that patients receive optimal stroke care. If the facility is unable to provide the appropriate level of care, then the facility should initiate immediate rapid ground or air transport to an appropriate hospital for suspected acute stroke patients. This applies to those patients who arrive by private car or by EMS when acute stroke was not suspected at dispatch or in the field.
3. **A stroke system should ensure that hospitals identified as "acute stroke capable" possess the appropriate resources and deliver primary stroke care, in accordance with national recommendations and local or national certifying bodies.** These resources should be organized under a stroke center director and include acute stroke teams, written care protocols, continuing medical education, interface with EMS, a stroke unit for stroke admissions, neuroimaging and laboratory services, access to neurosurgical services, and the commitment and support of the hospital's medical and administrative staff. Hospital certification, designation, or licensure may be accomplished through a variety of organizations (eg, nonprofit companies, state health agencies, professional societies, or JCAHO) based on these national recommendations.
4. **A stroke system should make certain that clinical pathways are used consistently to ensure the organized application of interventions to prevent or limit stroke progression or secondary complications.** These clinical pathways should be based on protocols adapted to each institution, reflecting well-established standards of care and national guidelines.
5. **A stroke system should identify the roles played by each type of hospital in the system and define the responsibilities inherent in those roles.** Hospitals with limited resources must develop plans to collaborate with nearby primary or more comprehensive stroke centers (or both), including formal transfer agreements. Primary and comprehensive stroke centers (ie, hospitals with specialized resources and personnel available to provide stroke treatment and rehabilitation that surpass the resources expected of primary stroke centers) should accept responsibility for collaborating with other facilities in ways that promote patient access to appropriate care. Each hospital should take responsibility for meeting its obligations to the broader stroke system.

Subacute Stroke Care and Secondary Prevention for Stroke

The treatment of stroke patients during the subacute phase, including the early implementation of secondary prevention regimens, is critical to optimizing patient outcomes. Well-established evidence-based guidelines are focused on subacute care and secondary prevention for stroke,[37,39,138–140] and patient outcomes can be improved through their consistent implementation. Systems approaches can provide important support mechanisms to help ensure that well-established evidence-based practice guidelines are put into practice in consistent ways, regardless of the patient care setting.

One important aspect of patient care in the subacute phase involves the treatment of progressing stroke. Approximately one third of stroke patients worsen during the initial 24 to 48 hours after stroke onset,[141] and early deterioration is associated with increased mortality and morbidity.

Organized and standardized efforts targeting prevention of common complications also are critical, including prevention, recognition, and treatment of myocardial infarction, deep vein thrombosis, pulmonary embolism, urinary tract infections, aspiration pneumonia, dehydration and poor nutrition, skin breakdown, and metabolic disorders. To optimize the therapeutic benefit, many of the steps necessary to avoid these complications should be initiated in the emergency department.

Improved clinical outcomes are realized when subacute stroke care is provided through the use of focused and organized approaches during hospitalization, including the use of short- and long-term stroke units.[11,98,99,142–146] These stroke units integrate acute and rehabilitative care by a well-trained, multidisciplinary group specializing in the care of stroke patients and commonly used clinical pathways and protocols, typically in a geographically defined area of the hospital. Stroke unit personnel include physicians, nurses, and rehabilitation personnel who engage in regular communication and other efforts to ensure the coordination of care. The magnitude of the benefits of stroke unit care is comparable to that of intravenous tPA and is applicable to the full spectrum of ischemic stroke patients.[138]

Efforts targeting secondary prevention of stroke in patients with previous stroke or transient ischemic attacks are important, focusing in large part on the same modifiable risk factors and interventions used in primary stroke prevention (see Primordial and Primary Prevention). Disease management and medication adherence interventions may help support

secondary prevention efforts.[42] For some patients, interventions such as carotid endarterectomy or anticoagulation may be indicated. Preventive strategies often are adopted slowly into common practice. Organized approaches initiated during hospitalization may improve adherence to secondary stroke-prevention guidelines.[147,148]

Patient compliance with treatment and prevention strategies depends on a number of factors including age, cause of stroke, and condition on hospital admission. Identifying these factors improves stroke prevention efforts.[149] An organized, standardized approach identifying barriers to compliance should begin promptly at hospital admission[150,151] and should include targeted physician education efforts with regard to secondary stroke prevention and availability of guidelines.[152]

The Task Force makes the following recommendations in the context of subacute treatment and secondary prevention of stroke:

1. **A stroke system should use organized approaches (eg, stroke teams, stroke units, and written protocols) to ensure that all patients receive appropriate subacute care.** Efforts should be targeted to recognize and treat deterioration after stroke, as well as the prevention of common complications occurring in the early poststroke period. Continuity of care should be pursued with therapies initiated during the hyperacute phase.
2. **A stroke system should adopt approaches to secondary prevention that address all major modifiable risk factors and that are consistent with the national guidelines for all patients with a history or suspected history of stroke or transient ischemic events.** To the extent that the majority of strokes occur secondary to atherosclerosis (a systemic disease that affects the entire circulatory system), stroke secondary prevention strategies also should address the relevant modifiable risk factors for heart disease and other cardiovascular diseases.
3. **A stroke system should ensure that stroke patients and their families receive education about stroke risk factors, warning signs, and the availability of time-sensitive therapy, as well as the appropriate method for activating EMS in their area.** Stroke systems should establish measurable goals for assessing the ability of stroke patients and their families to demonstrate new knowledge as a result of this intervention.
4. **A stroke system should ensure a smooth transition from inpatient to outpatient care, including timely transfer of hospital discharge information to the subsequent treating physician and a clear method of appropriate follow-up.**

Rehabilitation of Stroke Patients

After a stroke, 50% to 70% of patients regain functional independence; however, 15% to 30% of patients are permanently disabled and 20% require institutional care at 3 months after onset.[1] Stroke rehabilitation involves a combined and coordinated use of medical, social, educational, and vocational measures for retraining individuals to reach their maximal physical, psychological, social, vocational, and avocational potential. Specifically, stroke rehabilitation programs are provided to optimize neurological recovery, teach compensatory strategies for residual deficits, teach activities of daily living (ADLs) and skills required for community living, and provide psychosocial and medical interventions to manage depression. The team provides patient and family education about the medical management of poststroke complications and secondary stroke prevention. Clear, comprehensive, and timely communication across the inpatient and outpatient poststroke continuum of care is essential to ensure appropriate medical and rehabilitation care.

Stroke rehabilitation should be provided by an appropriately trained and staffed transdisciplinary team, including neurorehabilitation physicians, rehabilitation nurses, physical and occupational therapists, speech-language pathologists, recreational therapists, social workers, neuropsychologists, vocational counselors, and families; the patient should be a fully involved member of this team.

The rehabilitation team should meet periodically to evaluate the stroke patient, to document functional gains, and to set short- and long-term goals. Rehabilitation may occur in different environments, including inpatient rehabilitation facilities, subacute rehabilitation units, skilled nursing facilities, outpatient facilities, and the patient's home through visiting nurse services. The type of environment in which the stroke survivor receives rehabilitation services should be determined by the expected prognosis for recovery, availability of caregiver support, and probability of discharge into the community. In selecting the site of stroke rehabilitation care, the patients' and caregivers' needs should be matched with the types and intensities of therapies required to optimize recovery, improve quality of life, and increase the probability of community living.

Rehabilitation is the primary treatment modality for patients recovering from stroke. Practice guidelines for rehabilitation are well established in this area,[153–155] although patients often do not receive a level of care that is consistent with these guidelines.[156,157] Third-party payers and other factors may influence the level of care in which stroke survivors receive their rehabilitation services.

A systems approach is particularly important to promote the effectiveness of rehabilitation for stroke, especially given the importance of effective communication among providers, facilities, patients, and family members.[153] Coordination and collaboration among all providers throughout the continuum of care are important to optimize patient outcomes, and rehabilitation should begin as soon as is medically feasible.[158,159]

The intensity of rehabilitation services often is a critical determinant in the recovery of stroke patients.[160,161] The use of coordinated, multidisciplinary stroke rehabilitation teams has been shown to diminish mortality rates for stroke patients.[162,163] In addition, stroke patients who receive care in an inpatient rehabilitation facility are more likely to return to the community and to recover their ability to perform ADLs.[164]

The linkages and coordination of care should be maintained to ensure adequate communication among the full set of professionals delivering rehabilitation services. In addition, communication should be pursued among those providing outpatient care in various settings, including secondary prevention.

The Task Force makes the following recommendations in the context of the rehabilitation of stroke patients:

1. **A stroke system should ensure that all stroke patients receive a standardized screening evaluation during the**

initial hospitalization to identify patients with residual impairments so that these patients receive appropriate rehabilitation. The use of a standardized evaluation provides important insights into the type and duration of rehabilitation therapy needed on a patient-by-patient basis. Evaluations for stroke rehabilitation should include a neurological assessment of residual deficits, assessment of functional status (ADLs), cognitive and psychological status, determination of previous functional status and medical comorbidities, the level of family/caregiver support, the likelihood of returning to community living, and the ability to participate in rehabilitation services.

2. **A stroke system should periodically assess its level of available rehabilitation services and resources.** Such an assessment should include the total number and types of beds available, the intensity of services provided in different settings, the presence of transdisciplinary coordinated teams, and the adequacy of care coordination programs. This assessment should consider the current and future needs in the system for inpatient care, as well as the relative mix among inpatient rehabilitation facilities, skilled nursing facilities, continuing care retirement communities, home care services, and outpatient services.
3. **Stroke patients should be referred to an inpatient facility, an outpatient facility, or a home care service that provides for their medical and functional needs.** The needs of the patient are driven in part by the potential for recovery and the potential for community discharge as determined by the initial assessment for rehabilitation services and subsequent clinical observations. The stroke system should develop performance measures that reflect the frequency at which patients receive the level of service that is appropriate for their condition. Research is needed to determine the impact of local practice variation and reimbursement policies on stroke outcomes in patients who receive other than the optimum level of rehabilitation services.
4. **A stroke system should establish support systems to ensure that patients discharged from hospitals and other facilities to their homes have appropriate follow-up and primary care arranged on discharge.** These efforts should include education and training for the patient and his or her family members. Clear, comprehensive, and timely communication across the inpatient and outpatient poststroke continuum of care is essential to ensure appropriate medical and rehabilitation care.

CQI Initiatives

A critical function of a systems approach to stroke care is the use of CQI strategies to ascertain whether and to what extent various efforts are succeeding in improving patient care.[5,6] CQI relies on data accessibility and transfer among all appropriate facilities and providers. A stroke system should be structured in a way that permits and facilitates the exchange of relevant clinical data (eg, time of symptom onset, EMS contact/dispatch, in-hospital test results) for CQI activities between hospital, EMS, and rehabilitation-based providers. This collaboration must be constructed to permit ease of data exchange while still complying with state and federal requirements, including those arising under the federal Health Insurance Portability and Accountability Act of 1996.

The performance measures chosen should reflect a combination of process and outcome measures that evolve as the stroke system matures. These measures should be identified through evidence-based methods or be driven by national expert consensus. Although process measures (eg, time to CT or use of stroke clinical pathways by facilities in the stroke system) often are the easiest parameters to measure, improvements in process measures may not always translate into improved patient outcomes.[165] Candidate performance measures for primary stroke centers have been developed and are being tested.[166,167] For this reason, appropriate measures of patient outcomes are necessary and may provide a more direct reflection of the effectiveness of the stroke system. It is important to note that performance measures often reflect an indirect measure of events, such as a reduction in a risk that is known to translate to a reduction of future events (eg, anticoagulation at discharge for atrial fibrillation) rather than a direct measure of the number of recurrent strokes in patients.

The Task Force makes the following recommendation in the context of CQI initiatives:

A stroke system should strive to optimize the overall effectiveness of the system and each of its individual components. This goal should be accomplished by identifying performance measures for each component and for the system function as a whole (both process and outcomes measures) and by employing CQI strategies in collaboration with key stakeholders. Evaluations of the system should examine overall patient outcomes, linkages among key stroke system components and linkages to other systems and entities, and obstacles to care and potential gaps. Furthermore, the stroke system should develop consensus performance measures and strategies for measuring, refining, and reassessing the following key stroke system components:

- Primordial and primary prevention, with performance measures to evaluate the implementation of widely recognized and emerging stroke prevention strategies
- Community education, evaluating community outreach initiatives by measuring the knowledge in the community about the causes, signs, and symptoms of stroke
- Notification and EMS, including data exchange between EMS and hospital teams so that relevant prehospital data can be incorporated into the CQI process
- Hyperacute stroke treatment, with performance measures involving the timeliness and effectiveness of the acute treatment of both ischemic and hemorrhagic stroke and the prevention of complications
- Subacute care and secondary prevention, including measures of patient outcomes and avoidance of complications and recurrent strokes
- Rehabilitation, with performance measures to evaluate patient outcomes (mortality, functional status, and community discharge) and the percentage of stroke patients who receive the appropriate level of rehabilitation services in the system

Conclusions

Building stroke systems throughout the United States is the critical next step in improving patient outcomes in the prevention, treatment, and rehabilitation of stroke. The current fragmented approach to stroke care in most regions of the United States provides inadequate linkages and coordination among the fundamental components of stroke care. Providers and policymakers at the local, state, and national levels can make significant contributions to reducing the devastating effects of stroke by working to promote coordinated systems that improve patient care.

Disclosure

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Robert J. Adams	Medical College of Georgia	National Heart, Lung, and Blood Institute	Nicolet; Acuson; ATL; Bristol-Myers Squibb; Boehringer Ingelheim	Boehringer Ingelheim; Bristol-Myers Squibb; Wyeth; Sanofi-Synthelabo; Novartis	None	Bristol-Myers Squibb; Sanofi-Synthelabo; Boehringer Ingelheim; Wyeth; Department of Veterans Affairs	None

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.

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KEY WORDS: AHA Policy Recommendations ■ stroke ■ brain ischemia ■ prevention ■ therapy