Setting New Directions for Stroke Care

The National Institute of Neurological Disorders and Stroke

Proceedings of a National Symposium on

Rapid Identification *and* Treatment *of* Acute Stroke

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Preface

I am pleased to present these proceedings from the December 1996 National Symposium on Rapid Identification and Treatment of Acute Stroke, sponsored by the National Institute of Neurological Disorders and Stroke. This document describes how we can change our health care system to create a Chain of Recovery necessary for treating patients with acute brain attack. The ideas discussed represent the consensus of a wide array of health professionals who for the first time can now offer effective treatment for acute stroke.

Many decades of painstaking research bring us to this point in time. Basic laboratory research, animal studies, and clinical trials all contributed to the accumulation of knowledge that led to the development of the stroke treatment now available. Currently available treatments have the potential to spare many ischemic stroke patients from a life of disability. More research to refine these treatments will guide us to even more effective interventions for the growing population of stroke-prone individuals.

A key to success in implementing the steps outlined in this volume will be cooperation among professionals from many disciplines. These include neurologists, neurosurgeons, emergency physicians and nurses, intensivists, emergency medical services personnel, radiologists and radiology technicians, epidemiologists, public educators, and others. To offer the best care for stroke, hospitals across the nation must develop Stroke Teams capable of responding immediately to the needs of stroke patients.

I am most grateful to the dozens of Partners who join us in this new era of stroke treatment. In addition to advising the NINDS during the symposium planning process, the Partners will play a pivotal role in helping the Institute disseminate the conference recommendations to those on the front lines of health care delivery.

On behalf of the NINDS staff, I am proud to present the medical community with this blueprint for achieving success in the treatment of all patients who experience stroke.

Zach W. Hall, Ph.D.
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National Institute of Neurological Disorders and Stroke

Proceedings of a National Symposium on Rapid Identification and Treatment of Acute Stroke

December 12-13, 1996

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Introduction

This monograph demarcates a new era in the treatment of stroke. Acute early intervention to reduce the disability caused by stroke has been shown to be effective. No longer can we stand by while stroke-threatened brain undergoes irreversible injury. The national effort to change the way stroke is treated began at a National Symposium on the Rapid Identification and Treatment of Acute Stroke held on December 12 and 13, 1996. The recommendations and conclusions of the participants at that Symposium are summarized in the following pages.

This monograph is not about one particular treatment for stroke or one particular type of stroke. All stroke presents as the sudden onset of a neurological deficit such as weakness, paralysis, or loss of speech. While the syndrome of strokes is the same, the causes can vary widely and be as different as bleeding in one case and the formation of a blood clot in another. Each type is treated differently. Common to all stroke types is the need for rapid emergency examination, diagnostic testing, and treatment, if possible, before the few minutes or hours pass that it takes for brain injury to become permanent. This monograph is about how the current medical system can be changed to meet the needs created by the recent demonstration that the majority of stroke patients could receive effective treatment if they could be seen and treated soon enough. Rapid response is required if we are to see the benefits resulting from decades of laboratory and clinical stroke research devoted to the development of effective methods to treat and prevent stroke from all causes.

The recommendations and suggestions presented in this monograph were developed during the Symposium by representatives from more than 50 organizations interested in the care of stroke patients. Many different points of view are included. The participants agree that rapid treatment of stroke is required if we are going to reduce disability and improve the quality of life for stroke victims. The actual systems needed to accomplish the task will be different in each community. A wide variety of recommendations for national planning and community action were developed by the participants. If successful, this monograph will facilitate planning and development of systems that give the same urgency of care to stroke patients that is given to patients with myocardial infarction and trauma.

John R. Marler, M.D.
Medical Officer
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Executive Summary

Executive Summary

The announcement, in late 1995, that acute ischemic stroke can be successfully treated with thrombolytic agents created the need for a national plan on how to make this treatment available to eligible patients as rapidly as possible. In response to this need, the National Institute of Neurological Disorders and Stroke sponsored a National Symposium on Rapid Identification and Treatment of Acute Stroke on December 12 and 13, 1996. The goal was to provide a platform for coordinating nationwide efforts aimed at implementing acute stroke therapy for all types of stroke. While thrombolytic therapy of ischemic stroke with t-PA was the impetus for this Symposium, it was recognized from the outset that the successful treatment of any type of stroke will require rapid response to all stroke types. The theme of the Symposium was that rapid evaluation and treatment will improve the outcome for all stroke patients.

This monograph presents the conclusions of the Symposium participants, who represented a full range of professionals involved in treating stroke patients, managing hospital and emergency response systems throughout the United States, and educating the public about health risks and new treatments.

Each year, 500,000 Americans suffer acute brain attacks, 400,000 of which are ischemic strokes caused by blood clots occluding brain arteries. The remainder are hemorrhagic strokes caused by intracerebral hemorrhage and subarachnoid hemorrhage. There are currently more than 3 million Americans living with some disability resulting from stroke. Therapy given promptly to carefully selected stroke victims could reduce the extent of this disability. To make prompt treatment widely available, a number of critical changes must be made in the nation's health care delivery systems. Specifically:

- *Prehospital emergency response systems* must train personnel to correctly identify potential candidates for treatment and work closely with hospital emergency departments to transport these patients

rapidly to appropriate stroke centers. Thrombolytic therapy for ischemic stroke requires an especially rapid response in the first few minutes after a patient arrives at a hospital.

- *Emergency departments* must have specialized protocols in place for identifying candidates for therapy and treating those that require therapy within a narrow therapeutic time window.
- *Hospitals* must develop comprehensive acute stroke plans that define the specialized roles of nursing staffs, diagnostic units, stroke teams, and other treatment services such as pharmacy and rehabilitation.
- To take full advantage of effective stroke treatment, all *health care systems* involved in managing eligible patients must be carefully integrated, taking into consideration the wide diversity of health care that exists throughout the United States, from rural settings with minimal access to specialized care to urban settings with a high volume of emergency patients.
- *Public education* is critically important in ensuring that all of the efforts cited above are successful. The public must learn that a brain attack is a medical emergency, that a treatment is now available for some stroke patients, and that this treatment is only effective when given within a few hours of the onset of symptoms.

As a first step in planning the Symposium, the NINDS created a Steering Committee whose members developed the overall Symposium goals, guided by the five domains above. The committee then created three task forces (Prehospital and Hospital Care, Health Care Systems, and Public Education), each of which had responsibility for setting the agenda for that topic area. The committee members for all groups are listed in the Appendices section of this monograph.

Another critical element in the planning and implementation of the Symposium was outreach to the many professional groups (*see* Partners in the Appendices) who will be instrumental in changing the existing health care system. These Partners include the full range of allied health professionals—emergency physicians and nurses, emergency medical services personnel, radiologists, neurologists, and many others. Also represented among the Partners are government agencies, such as the Food and Drug Administration and the Health Care Financing Administration, and private advocacy groups, such as the Dana Alliance for Brain Initiatives and the National Coalition for Research in Neurological Disorders. By involving all such interested parties in the Symposium the NINDS hoped to reach into every corner of the national health care system to ensure that nothing was overlooked as we developed a consensus on a national stroke treatment plan.

Full details of the conclusions reached at the Symposium can be found in the Recommendations section of this monograph. The following represents an overview of these recommendations:

Prehospital Emergency Medical Care Systems:

- EMS personnel must be trained to treat stroke as a time-dependent, urgent medical emergency, similar to acute myocardial infarction.
- A Chain of Recovery—beginning with the identification (either by the patient or an onlooker) of a possible stroke in progress and ending with a rehabilitation plan—must be established in every community of the country.
- New educational initiatives must be developed and implemented for all medical personnel in the Chain of Recovery, including 911 dispatchers, EMS technicians, and air medical transport personnel. This will require the creation of task forces to develop model educational initiatives, and standardized data sets to help ensure effective research and outcomes analyses.

Emergency Department:

- Acute stroke patients should be classified as quickly as possible to identify those eligible for thrombolytic therapy. Although this classification will often be done by physicians in emergency departments, it may also be accomplished by others, e.g., prehospital care providers, triage nurses, or other individuals competent to apply categorization criteria. Patients deemed ineligible for thrombolytic therapy will undergo a different rapid categorization to establish what treatment they should receive.
- Response systems, including optimal time-frames, must be established, maintained, and monitored in all emergency departments. The goal should be to (a) perform an initial patient evaluation within 10 minutes of arrival in the emergency department, (b) notify the stroke team within 15 minutes of arrival, (c) initiate a CT scan within 25 minutes of arrival, (d) interpret the CT scan within 45 minutes of arrival, (e) ensure a door-to-drug (needle) time of 60 minutes from arrival, and (f) transfer the patient to an inpatient setting within 3 hours of arrival.
- Although medical management of blood pressure remains a controversial and complex topic, general guidelines were outlined at the Symposium. For example, for acute stroke patients who are candidates for thrombolytic therapy antihypertensive treatment should not be given if systolic blood pressure is less than 185 mm Hg or diastolic pressure is less than 105 mm Hg. Acute stroke patients with a diastolic pressure greater than 140 mm Hg or a systolic pressure greater than 220 mm Hg on two readings are generally not candidates for thrombolytic therapy, although antihypertensive treatment should be given.

Acute Hospital Care:

- Every hospital providing care to stroke patients should develop a Stroke Plan that defines the optimal treatment pathways appropriate for that particular institution.
- Patients who meet thrombolytic treatment criteria should have access to stroke expertise within 15 minutes of hospital arrival and neurosurgical expertise within 2 hours of hospital arrival. Other time-frame recommendations are outlined above under Emergency Department.
- A Stroke Toolbox containing guidelines, algorithms, critical pathways, NIH Stroke Scale training tapes, and other stroke templates should be created, updated, and made easily available through the NINDS.
- Health professional training programs should be modified to include standards of acute stroke care, and the Acute Health Care Panel endorsed specialty-specific continuing medical education related to acute stroke.
- Criteria for primary, intermediate, and comprehensive stroke centers should be established.
- Communities should be encouraged to create local and regional stroke networks encompassing all levels of acute stroke care.

Health Care Systems:

- Creating an efficient stroke care delivery system should start with identifying committed prehospital and hospital leaders who will act as "champions." The task of these champions will be to develop and sustain teams for managing stroke patients through the various phases of care. Champions should use flow-charting techniques to help them understand the current components of care, decide on necessary modifications, and implement these modifications.
- All components of the stroke care delivery system must be integrated functionally, financially, and legally so they work together seamlessly. Those who activate the acute stroke treatment system should work with the approach that "one call does it all," with everyone on the team linked with pagers or cellular phones.
- Key indicators for acceptable outcomes of acute stroke care must be identified. Indicators should be established for the prehospital setting, the emergency department, and the acute stroke care unit within the hospital, as well as for the variety of discharge settings, including rehabilitation facilities.

Public Education:

- Behavior change is achievable, as demonstrated by many past public education successes. But change occurs slowly, so those implementing public education campaigns must be persistent and patient.
- Big, comprehensive programs that employ many communications vehicles are the most effective.
- Motivation to change occurs when the public perceives that the benefits of change exceed the cost of change. The messages about seeking prompt health care after a stroke must be simple, clear, and repeated often.
- We must understand our audience, which is comprised of many subgroups with different backgrounds and different methods of learning. Messages must be tailored to these various groups.
- Success is most likely if public educators follow a Madison Avenue approach to delivering messages. In this approach, strategy always precedes execution, and the best strategy tool to use is the creative brief, a document that defines the target audience, identifies the desired actions to be taken by that audience, presents current consumer beliefs and barriers to taking action, and establishes long-term goals.
- Strong national leadership will be required to move this initiative forward, and the Public Education Panel recommended that the NINDS take this leadership role.

The goal of successfully delivering thrombolytic therapy to all eligible ischemic stroke patients is an achievable one, but one that will take a great deal of thoughtful and informed decision-making. The NINDS, working closely with the Acute Stroke Partners and the Brain Attack Coalition,* are confident that changes in the health care delivery system will occur and that thousands of Americans will be spared many of the catastrophic disabilities that currently afflict more than 3 million surviving stroke victims.

** The Brain Attack Coalition is a group of national organizations dedicated to reducing the occurrence of stroke and death and disability associated with stroke. The Coalition facilitates coordination and communication among the many groups involved in stroke care and education, and is currently chaired by the National Institute of Neurological Disorders and Stroke.*

Keynote Addresses

Keynote Address:

Magnitude of the Problem of Stroke and the Significance of Acute Intervention

Patrick D. Lyden, M.D.
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Stroke is a serious and common illness. Data on the incidence of stroke, collected by the American Heart Association, indicate that in the United States there is a stroke about every minute and a person dies of stroke about every 3 ½ minutes. At the moment, there are 3 to 4 million Americans who had a stroke yet are still alive. The death rate is approximately 30% of all stroke victims. This rate has declined significantly over the last several decades, not due to therapy for stroke, but due to excellent treatment of the complications that occur after a stroke.

We can put the stroke problem into perspective by comparing it to other neurological illnesses (Figures 1A and 1B). For example, Parkinson's disease affects about 50,000 new patients every year, and there are now at least 350,000 Americans with Parkinson's disease. Every year about 400,000 new cases of Alzheimer's disease are diagnosed; there are about 1 million people alive with the disease. About 125,000 new cases of epilepsy occur each year and about 2 million Americans are currently affected. Traumatic brain injury affects 300,000 cases each year; new brain tumors are found in 25,000 people each year.

Clearly, stroke affects more people every year than any of these other illnesses, with Alzheimer's disease coming closest—about 400,000 new cases compared to 500,000 new cases of stroke. And in terms of survivors—patients who require care and patients who require resources—the 3 to 4 million stroke patients far and away present the biggest problem.

What happens to stroke survivors? Recent studies of acute stroke using the modified Rankin disability scale, in which the worst outcome is death (a Rankin score of 5), show that the percentage of patients who die is between 16 and 23% in the first 3 months. On the Rankin scale, a score of 0 or 1 indicates a good outcome, or normal recovery, after stroke. In these studies, only 25% of patients recover fully. Considering the 20% who die, this leaves approximately 55% of stroke patients (those with a Rankin score of 2, 3, or 4) with varying degrees of disability at 3 months after stroke. These numbers are approximately the same at 1 year after the stroke. It is this group that creates an ongoing burden to society, to the patient, and to their families.

Figure 1A. Prevalence of survivors of various disabling neurological conditions.

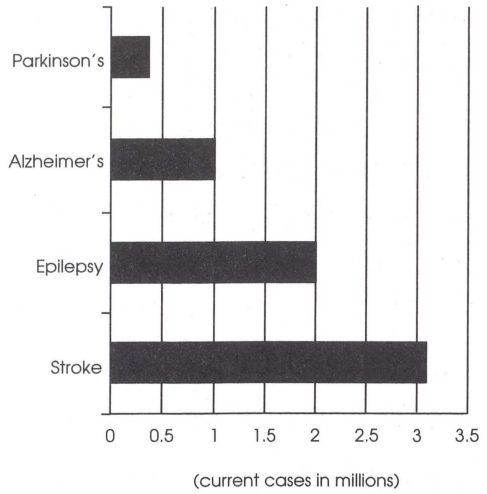
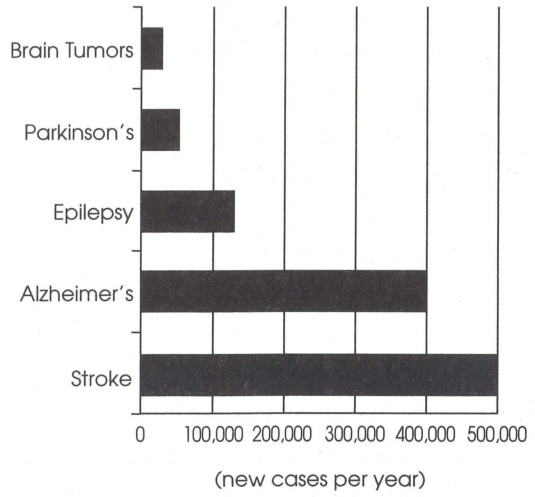
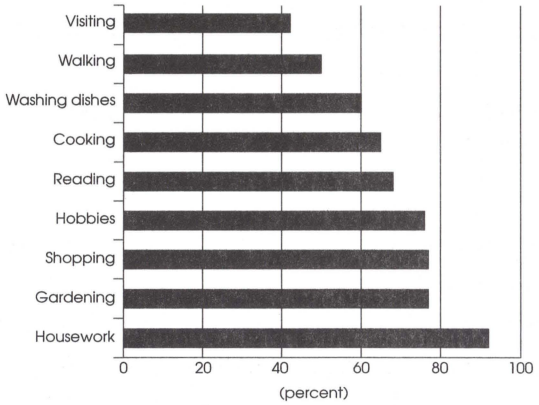


Figure 1B. Incidence of new cases of various disabling neurological conditions.



These patients are impaired in basic activities of daily living—feeding, bathing, and grooming. What other limitations do handicapped stroke survivors face? Figure 2 shows the results of a survey of such patients (1). The most interesting finding is that 40% of handicapped survivors feel they can no longer visit people. Other significant handicaps include impairments in walking, helping around the house, doing dishes, and cooking. Almost 70% of handicapped stroke survivors report that they can't read. Life for stroke survivors can be bleak: they are no longer as mobile as they once were; they can't read books or the newspaper; they can't enjoy hobbies as they once did; they can't help with the shopping or the gardening. Almost 100% can't help out with the housework. The magnitude of the problem to the individual is enormous.

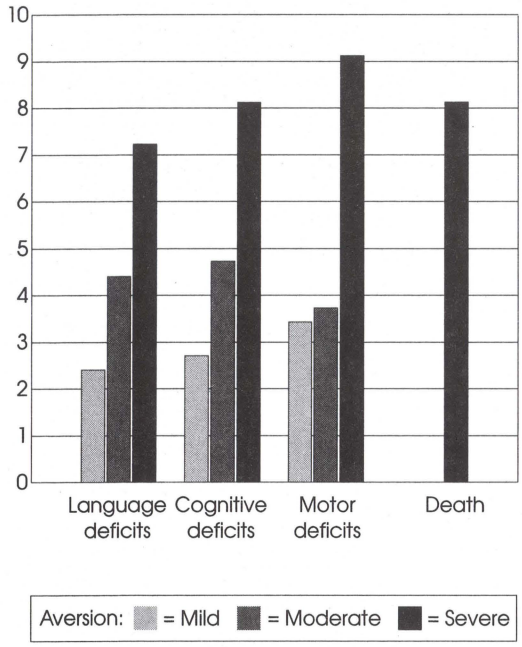
Figure 2. Self-reported limitations faced by handicapped stroke survivors.



From Anderson CS, et al (1). Used with permission. Copyright 1995, American Heart Association.

We are only beginning to understand how patients react to and feel about their stroke. In the survey results shown in Figure 3, patients rated their reactions to a series of scenarios, ranging from mild deficits in language, cognition, or motor function up to death (2). Increasing scores on this scale describe the patient's aversion to that par-

Figure 3. Patient aversion to various stroke outcomes.



From Solomon NA, et al (2). Used with permission. Copyright 1994, American Heart Association.

ticular outcome. What is interesting to me is that a severe motor, cognitive, or language deficit is about the same as dying to elderly patients. In fact, patients would almost rather die than be left with a severe motor or cognitive deficit.

In addition to not being able to do what they once did, these patients require help from outside the home. About half of them need day-hospital services, 40% need home help, 40% have a visiting nurse, and 14% need Meals on Wheels. Another area that we have only begun to explore is the burden on the caregiver. Most of the 50 to 70% of stroke survivors who are handicapped after 1 year require help. If you survey the caregivers and patients, most caregivers respond that they have insufficient resources, meaning financial as well as personal resources. And, not surprisingly, half of the caregivers develop an emotional illness at 1 year after their family member's stroke, primarily depression, but also anxiety and other problems. Caregivers are most often female, either a spouse or a daughter of the victim. And most of these people are forced to give up something, either a job outside the home or time with their own family. This burden and the cost of this burden are enormous and are not yet quantified.

Stroke can result from several different diseases. Of the 500,000 strokes that occur each year, 400,000 are caused by infarctions (most are first-time strokes, some are second-time strokes), and 100,000 are hemorrhagic, either intracerebral or subarachnoid (Figure 4). A hemorrhagic stroke can be a hematoma, a disease that occurs in the same age group and is associated with the same risk factors as infarction. But unlike patients with infarctions, about 60% of patients with a hematoma die. And most of the survivors are left gravely disabled. Subarachnoid hemorrhage is a disease of young and middle-aged adults. There are about 30,000 of these cases every year: 80% of them are due to a ruptured berry aneurysm, 50% of them are fatal, and half of the survivors are left disabled. These patients, since they are only 30 or 40 years old at the time of the stroke, require the same services as older stroke patients but for a much longer period of time. Serious complications of subarachnoid hemorrhage include vasospasm, which can be treated.

Stroke is a very expensive disease. Of the first-year costs, 50% accrues during inpatient hospitalization. But the distribution of costs among patients is skewed: 10% of people account for about 30% of the total cost. And although 80% of strokes are from infarctions, only half of the costs are due to infarction, indicating that hemorrhages account for a disproportionate share of the cost of stroke.

Figure 4. Incidence and prevalence of stroke.

- 400,000 ischemic strokes per year
  - 75% first time
  - 20% second time
- 100,000 hemorrhagic strokes per year
- 3.1 million current cases

Medical costs for a patient with a mild stroke are approximately $8,000. For patients with more severe strokes, including patients with intracerebral hemorrhage, the cost is approximately $15,000 for an admission for the first year. For patients with subarachnoid hemorrhage, the cost is almost $30,000. These patients are more seriously ill. They spend more time in intensive care units and require more care after discharge from the hospital.

Dying from a stroke doesn't save money. If a patient dies of a stroke, the cost is approximately the same as the cost of caring for a stroke inpatient. A TIA costs about $4,000, on average, for an inpatient. A fatal intracerebral hemorrhage is slightly less expensive than a stroke, and a fatal subarachnoid hemorrhage is about $10,000 less. As we analyze the decision-making process, it isn't necessarily cost-saving to have patients die of their disease.

Finally, I would like to pose a question: "Why don't we get the chance to treat patients more often?" Using data from the NINDS t-PA Stroke Study (3), we find that of the 16,000 potentially eligible patients (those who came to a hospital within 24 hours of their stroke), we were able to diagnose and treat about 600. Most commonly, we could not treat patients because they arrived too late to the hospital (50%). Identifying patients and getting them to the hospital rapidly are the primary obstacles to effective treatment of stroke patients.

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Keynote Address:

The Importance of Time

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What is the Biologic Basis of a Therapeutic Time Window?

Recent progress in the treatment of acute ischemic stroke is to a great extent the result of two major basic research themes evolving over the past 20 years: (a) our ability to measure cerebral blood flow (CBF) and metabolism and the resultant observation that the first minutes to hours after a stroke is a period of dynamic (and potentially reversible) change, and (b) the development of appropriate animal models of stroke that allowed us to explore the components and duration of this dynamic.

Studies of CBF and metabolism. Most methods of measuring CBF are based on the Kety-Schmidt principle that the flow of a nonmetabolized and diffusible tracer is proportional to its wash-out from the organ. Using radiolabeled xenon or hydrogen clearance, it was soon learned that flow in brain regions supplied by an occluded artery is variably reduced depending in part on the distance of the region from the stroke epicenter, and that flow in much of these regions was sufficient to maintain viability for some period of time as evidenced by correlative measurements of oxygen or glucose metabolism in the same regions. The brain regions that were threatened but viable were termed the "ischemic penumbra," and the time this penumbra could remain viable was termed the "therapeutic time window." It was also appreciated that flow usually is restored spontaneously (and may even become greater than normal [hyperemic]) in most penumbral brain regions after a stroke, but that this did not result in tissue survival unless reperfusion occurred within the therapeutic time window. Finally, we learned that the more profound the reduction of blood flow, the briefer this window became; with flow reduced to essentially zero, as after cardiac arrest, tissue death became inevitable after 10 minutes, whereas flow of about 15 cc/100 gm of brain tissue/minute such as is measured after focal stroke could be tolerated for substantially longer.

Stroke models. Animal models of stroke were needed to allow us to identify which pathophysiological events are set in motion by the occlusion of an artery supplying the brain, and how these events lead to cellular destruction. While our knowledge is still incomplete, numerous therapeutic strategies aimed at rectifying or reversing steps along this "ischemic cascade" have been shown to reduce ischemic damage in these models and are under development and in various stages of clinical evaluation (1,2). It is likely that combinations of such strategies will be most successful. Animal models have also allowed us to study the therapeutic time window for each of these strategies.

What Have Animal Models Taught Us About the Therapeutic Time Window?

Scientists have developed numerous animal models, including rodents, that allow reperfusion after variable durations of middle cerebral artery occlusion. Most studies in these models have consistently shown that reperfusion within 3 hours of arterial occlusion will limit to some extent the size of the resulting infarct and improve other measures of outcome as well (3,4). These studies also show, however, that reperfusion after the 3-hour time point will have little or no benefit or may make things worse (5). In fact, understanding the pathophysiology of such "reperfusion injury" now assumes greater importance since some patients treated with t-PA even within the 3-hour time window will develop cerebral edema and/or hemorrhage (6), and others may harbor less obvious consequences of reperfusion at the cellular level which negate the benefits of re-establishing adequate blood flow. If we can work out the important components of the phenomenon of reperfusion injury, we may make thrombolytic therapy both safer and applicable to a larger number of patients treated beyond the 3-hour time point.

Animal models have also shown that, at least within the first few minutes to hours after the onset of ischemia, the ultimate fate of tissue after reperfusion is dependent on two main variables: the duration and the depth of hypoperfusion (3). Consequently, effectively and safely selecting patients for thrombolysis depends on knowing both of these variables. To date, clinical studies have used only the stopwatch without an on-line measurement of cerebral hypoperfusion. Until we better understand reperfusion injury and find a way to measure CBF and tissue viability acutely, we must recognize that the only conclusively positive clinical study of reperfusion (7) was exactly predicted by animal models: patients must be treated within 3 hours.

Animal models also provide us with clues about which neuroprotective strategies might work and how to apply them. These studies suggest that in the first minutes after the onset of ischemia, the release of glutamate and rising intracellular calcium play pivotal roles in the fate of tissue in the ischemic penumbra, that other "downstream" events may also be important especially in reperfusion injury, and that combination therapy using two or more neuroprotective strategies is better than monotherapy. It is particularly impor-

tant to emphasize to laboratory researchers working with animal models that the biology of neuronal repair and recovery is still very poorly understood. Much more attention must be focused on this aspect of experimental ischemic injury in order to design therapies that may be useful if started in the subacute or chronic stages of stroke.

The lessons to clinical investigators from these animal data are that:

1. Neuroprotective therapy targeting neurotransmitter release and intracellular calcium-mediated events must be started very early after focal ischemia (the exact time window is unknown but none of these strategies has been effective in reducing infarct volume after middle cerebral artery occlusion in animals when started beyond 1-2 hours after the onset of ischemia), so prehospital treatment or prophylactic therapy of high-risk patients (i.e., those scheduled to receive coronary artery bypass or carotid endarterectomy) should be considered in the design of clinical trials.

2. If the target is penumbral regions, the clinical benefit may be modest and not very dramatic, mandating an adequate sample size and careful long-term followup and outcome assessment.

3. More than lip service needs to be paid to the idea of combination therapies. At least within the first 3 hours of stroke, neuroprotective therapies will now have to be tested in combination with t-PA for those patients meeting the criteria for thrombolytic therapy. It is possible that a neuroprotective monotherapy will be effective if started beyond this time point and several such trials are presently under way. However, animal studies (and clinical experience) predict that neuroprotective trials of extended time window monotherapy will be negative or equivocal. After that, we hope that instead of giving up on the concept of neuroprotection, we will overcome the practical obstacles and carry out prophylactic or prehospital trials of rational combination therapy.

Can We Deliver Acute Stroke Therapy Within the Time Window?

Despite the biologic considerations indicating the "need for speed" in evaluating and treating acute stroke patients, current recognition and treatment of stroke patients is usually too slow to allow therapy within the therapeutic time window. This is due to many factors, including lack of public awareness of stroke symptoms and the importance of early recognition and treatment; "neglect" of important neurological deficits by the patient due to involvement of sensory brain regions; unrecognized onset of symptoms during sleep; unavailability of family or friends to provide help in seeking rapid medical attention; unavailability or underuse of the 911 system for immediate stroke transport; lack of prioritization for rapid transport of stroke patients by prehospital emergency medical services (EMS) systems; lack of prioritization or an efficient system for stroke triage, diagnosis (especially brain CT to exclude hemorrhage), and treatment within the emergency department (ED); lack of knowledge among emergency medical care providers about acute stroke and its treatment; and lack

of neurological expertise in the acute ED setting (8). These factors pose an immense "systems" problem, but solutions have been achieved for other conditions such as trauma and heart attack (9).

For medical personnel, it is most expedient to focus efforts on improving the EMS, ED, and physician response to patients with acute stroke (10). In conducting a trial of thrombolysis for acute stroke in our community, we studied the existing state of EMS and emergency stroke management at eight participating hospitals, focusing particularly on system delays (11). We then evaluated the impact of a dedicated "stroke team" on our ability to complete the transport, triage, diagnosis, and treatment of patients within the therapeutic time window. The hospitals included a large fully affiliated private medical school teaching hospital, large and small private community hospitals with variable teaching roles, and a public urban teaching institution. They ranged in bed capacity from 175 to 979. Our stroke team consisted of neurologists and registered nurses who specialize in acute stroke therapy. One physician and one nurse were on call 24 hours a day, 7 days a week. Inservicing of the Houston Fire Department EMS personnel was carried out by the stroke team with specific instructions to rapidly transport all acute stroke patients and to immediately notify the stroke team. A communications system was set up with a dedicated beeper activated by EMS or the ED triage nurse and worn by both the stroke team physician and nurse on call for any acute stroke patient transported to or arriving at a participating hospital ED. Stroke team personnel were equipped with cellular phones and appropriate lists of key personnel such as CT technicians who would be notified and activated while the team was en route. Patient, pharmacy, laboratory, and radiographic (CT) movement and procedures were flow-charted within each ED and algorithms and guidelines were developed to speed assessment and treatment.

In the total population of acute stroke patients arriving at participating EDs within 6 hours of symptom onset, the mean time from onset of stroke symptoms to arrival at the ED was 115 minutes; there was no difference between patients arriving by ambulance or private vehicle. The mean interval from ED arrival to placement in an ED room was 11 minutes.

In the absence of the stroke team, patients were seen by a physician a mean of 28 minutes after arrival at the ED. Patients arriving by ambulance were examined by the ED physician more rapidly (20 minutes) than those arriving by car (48 minutes). Stroke patients were in the ED for a mean of 123 minutes before they were seen by a neurologist, and 100 minutes before a brain CT scan was performed. While vital signs were obtained within 7 minutes, drawing blood took 48 minutes and obtaining an electrocardiogram took 61 minutes. Patients stayed in the ED from arrival to disposition for a mean of 324 minutes. These intervals were not substantially different among the different hospitals regardless of type or size except that the public hospital was slightly slower and the smaller community hospitals had less documentation of neurological findings and slower access to neurological consultation.

All intervals were shortened when the stroke team was activated. For example, in the teaching hospital, the mean interval from ED arrival to completion of the entire evaluation of the patient including CT (i.e., "door to needle time") was reduced from 139 to 50 minutes.

We conclude that EMS, triage, CT scanning, neurological consultation, and medical attention for most acute stroke patients is too slow to allow treatment within the therapeutic time window. Upgrading EMS transport from Code I (nonurgent) or II (emergent) to Code III (life-threatening) might help. Selection of patients for potentially dangerous stroke therapies may be problematic in smaller community hospitals if neurological consultation is not available. Rapid availability of CT scanning is essential since 25% of our patients had intracerebral hemorrhage or non-ischemic cause for their acute stroke symptoms, yet the interval was 2 hours between ED arrival and CT scanning. Despite these findings, most EMS and ED stroke management problems can be corrected by faster patient transport and medical evaluation, the availability of an acute stroke team, and education of ED physicians and nurses.

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Keynote Address:

Acute Medical Care in the United States

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In the United States, acute medical care is delivered in a variety of settings. Although some minor acute care is delivered in physicians' offices and free-standing urgent care centers, the majority of major acute medical care is delivered in hospital-based emergency departments (EDs). The development of hospital-based EDs is a relatively recent phenomenon, evolving in the 1960s. In 1993, there were more than 5,600 hospital-based EDs in the United States serving more than 95 million patients annually (1).

In 1967, Robert H. Kennedy, who had formerly been the chairman of the Committee of Trauma for the College of Surgeons, established the standards for emergency medical services (EMS) in the United States. Although the development of EMS emphasized injured patients, it was recognized that patients with acute medical conditions also required such emergency services (2). The late 1960s also saw the development of the first mobile coronary care units, which became the predecessors for modern advanced life-support ambulance services. The first emergency medicine training program was established in Cincinnati in 1969 and there are currently 110 accredited emergency medicine training programs in the United States (3). Although there are more than 25,000 physicians currently staffing EDs in the United States, there are only 13,000 emergency physicians with board certification from the American Board of Emergency Medicine (1).

Although the systems for care of acutely ill and injured patients are dynamic, acute medical care will likely continue to revolve around the coordination of EMS and hospital EDs. There has been notable success in advancing the care of trauma patients and patients with acute myocardial infarction. This presentation will focus on the structure of EMS in the United States and describe the development of programs for the treatment of trauma and acute myocardial infarction.

Emergency Medical Services

The local organization of EMS is not uniform and takes a variety of different forms often determined by historical factors and natural and political boundaries. Although there are many specific structures, five basic types of EMS organizations exist (4).

1. *Fire Service*—This is probably the most common type of EMS structure. In this model, the fire department will coordinate and run EMS. Due to advances in fire detection and prevention, the main business in many fire departments has shifted from fire service to EMS over the last 5 to 10 years. In many areas, fire personnel are used as first responders for basic life-support/emergency medical technicians and will be backed up by paramedics or advanced life-support personnel.

2. *Third Service*—In a third service model, EMS may be governed by municipalities or regional authorities but is separate from police and fire services. In this type of organization, the EMS coverage is not limited to the same municipal areas as the fire and police services.

3. *Private Providers*—Private ambulance companies provide prehospital care on a contract basis throughout much of the country. Although private providers will often provide acute medical care, they are more often used as backups to the acute medical care system and for patient transfers between institutions.

4. *Volunteer Services*—Volunteer EMS providers are more common in small and rural communities. Although these services may be independent, they are often part of a fire department or other governmental agency.

5. *Hospital-Based Systems*—In this model, the prehospital care providers are employed and owned by the hospital or health system. Hospital-based systems frequently will include air medical services as well.

Any system for acute medical care will need to incorporate certain basic components. There must be a method for patients to access the system, some prioritization of the information received from the access call and dispatch of appropriate services, and finally procedures for appropriately trained technicians to respond to the call and provide appropriate care and transport.

Patient access to EMS must be simple and reliable. The method most commonly used in the United States is the 911 enhanced telephone system (5). In parts of the country without 911, other access numbers are used. Regardless of the type of system, public education is vital to ensure that all citizens understand how to access EMS. Public education is also needed so that patients understand conditions for which EMS is essential.

Once EMS is contacted, communication will be with a dispatcher. The dispatcher has several key roles. First, the dispatcher will attempt to assess the nature of the complaint. Based upon the assessment of the complaint, the dispatcher may deliver

prearrival instructions for medical care prior to arrival of the EMS providers. In advanced systems, the dispatcher will determine the need for a basic or an advanced life-support response and the priority of the response. A key aspect in measuring the effectiveness of dispatch is maintenance of adequate and accurate time logs that indicate the time the call was received and the time at which EMS arrived at the scene. Most EMS services will have a tiered response system. In a tiered system, medical first responders or basic EMTs will be dispatched immediately to the scene and will assess the patient. Transport to the hospital may be through these first responders. If the nature of the illness or injury is one which requires advanced life support, the first responders will request a second tier or a paramedic response. In some systems, the dispatcher may determine that the nature of the complaint requires an advanced response rather than an initial response by first responders. In these cases, the advanced life-support or paramedic units will be the first responders to the scene.

On-site response requirements for selection and training of personnel at different levels of care will vary from state to state and municipality to municipality. The number of hours of training for paramedic certification can vary substantially from state to state. Standard certifications in order of increasing skill level are first responder, basic EMT, intermediate EMT, and paramedic. Medical direction and control is an integral part of all prehospital systems. On-line medical control indicates communication that occurs between medical control personnel and the prehospital provider usually via cellular phones or two-way radios. Off-line medical control includes all other areas. One form of off-line medical control is patient care protocols. These protocols are by and large developed on a local level and may vary considerably. These patient care protocols will allow the prehospital providers to initiate certain treatments in the field without on-line medical control or physician orders. The patient care protocols may vary tremendously in the degree of autonomy they give to the prehospital providers. For example, paramedics in certain areas can perform rapid sequence intubation in the field using neuromuscular blocking agents.

The destination of the patient after EMS systems are activated may also vary from community to community. For most complaints, patients will be taken to the hospital they request unless standing protocols contravene such requests. In situations where patients are deemed to be unstable, transport to the nearest facility will usually be done regardless of the patient's request. In areas that have a regionalized trauma protocol, traumatized patients meeting certain criteria will usually be taken to a designated trauma center even if this means bypassing a closer hospital or the patient's choice of hospital.

Trauma Services

The establishment of trauma systems in the United States and elsewhere has been a major development in the last 20-30 years and has clearly led to improved survival and outcome (6). The impetus for the development of trauma systems occurred primarily through the military experience. It was clearly demonstrated in statistics from World War I, World War II, the Korean Conflict, and the Vietnam War that improving the access of battle casualties to definitive care led to a lowering of mortality.

In World War II, the time from injury to definitive surgical care ranged from 6 to 12 hours and mortality was 5.8%. In the Vietnam War, the average time from injury to emergency care was 65-80 minutes and the mortality was 1.7%. In the United States, development of a trauma system in Orange County, California, led to a reduction in preventable deaths from 73 to 9% when patients were treated in one of five designated trauma centers (7). For patients who were sent inappropriately to a non-trauma center hospital, the preventable mortality rate remained at 67%. It has been estimated that development of regionalized trauma systems will reduce mortality by 33%.

Development of a trauma care system requires a major commitment from medical and health professionals and the public. One of the key aspects in creating public support is to establish the need for improved trauma care. This requires the collection of extensive data on the nature and frequency of injuries, percentage of the population involved in trauma, trauma severity, deaths, and disabilities. Once the need has been demonstrated, legal authority is necessary for the development of such a system. Typically a public agency may be established with the responsibility to develop criteria for the system, establish prehospital protocols, designate appropriate facilities, establish a trauma registry, and monitor quality improvement programs. The key factor in establishing a trauma system is the formation of a team approach to the care of the trauma patient that involves all individuals at every stage of management. This would include prehospital providers, emergency physicians and nurses, trauma surgeons, anesthesia and operating room personnel, and rehabilitation staff. The American College of Surgeons (ACS) has developed a verification process for trauma centers which establishes the capabilities of an institution to care for different levels of trauma (8).

A key feature of the ACS verification process is the need for system evaluation. A trauma system must be able to keep accurate data on its own performance and establish thresholds for key features of patient management. Changes in the system should be driven by the quality improvement program and adequate data should be gathered to assess the impact on patient outcomes of changes to the system.

Another important component of the ACS process is the carefully prescribed hierarchy of the trauma team composition and the designation of the trauma surgeon as the team leader and focus. Facility requirements, credentialing requirements, and the quality improvement process are also carefully spelled out. The verification process includes a paper review as well as an on-site visit with chart reviews and interviews.

Myocardial Infarction

Like trauma systems, processes for the improvement of care to patients suffering acute myocardial infarction (AMI) have led to improvements in care and decreases in mortality (9). The advent of thrombolytic treatment and angioplasty requires teamwork and an efficient system for patient evaluation and entry into treatment protocols.

AMI is the leading cause of death in the United States (10). Although death rates have declined by 54% since 1963, almost 500,000 people will die each year in the United States from AMI. Acute mortality and long-term morbidity are determined largely by the extent to which the myocardium is damaged by the AMI (11). There are two main reasons for advocating early arrival and treatment for AMI: (a) most AMI deaths will occur within the first hour after symptom onset and are due to cardiac dysrhythmias, and (b) early treatment with thrombolytic therapy will decrease mortality (12-14).

The greatest reduction in mortality is achieved in patients who are treated within 1 hour of symptom onset (15,16). In one trial, patients receiving treatment within 1 hour had a mortality of 1.3% compared with 8.7% in patients treated later (9). In 1991, the National Heart, Lung, and Blood Institute launched the National Heart Attack Alert Program (NHAAP) to promote rapid identification and treatment of patients with AMI (17). The thrust of these efforts was to reduce morbidity and mortality from AMI. The program sought to reduce the time from symptom onset to treatment into identifiable time phases and to analyze each phase in detail. These phases include patient/bystander factors (those that delay recognition and access to care), prehospital factors (those that occur from the time medical care is accessed to arrival at the hospital), and hospital factors (those that delay treatment after arrival at the hospital).

In distinction to the development of trauma systems where the system is prescribed in detail and the results of the system are measured and analyzed, the NHAAP identified a set of goals for treatment without specifying in detail how those goals should be reached in an individual institution. The NHAAP identified a time of 60 minutes from symptom onset to treatment as the goal for programs designed to reduce mortality from AMI. The time from ED arrival to treatment should ideally be 30 minutes or less. Suggestions were made for ways to realize these goals but the achievement of the goals is the main endpoint rather than the formation of the system.

Conclusion

Acute medical care in the United States is at its best when managing patients with major trauma or AMI. In developing systems for acute stroke treatment, important lessons can be learned from an in-depth analysis of the procedures and systems for treatment of AMI and trauma victims. It is unlikely that either system will be utilized in exactly the same way for stroke treatment, but we hope the end results of decreased morbidity and mortality will be achieved.

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Prehospital Emergency Medical Care Systems Panel

Prehospital Emergency Medical Care Systems Panel

Overview: Prehospital Emergency Medical Care Systems

The Initial Links in the *Chain of Recovery* for Brain Attack–Access, Prehospital Care, Notification, and Transport

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Synopsis

Beyond the clear need for public education initiatives, the currently available educational offerings and clinical approaches practiced in most emergency medical systems indicate that widespread re-education and re-orientation of prehospital care services are now clearly in order if we want to ensure the optimal management of patients with acute stroke.

Introduction

With the recent recognition of the potential for reversing or ameliorating acute stroke through early intervention(s) (1-5), patients with brain attack have now joined the ranks of those with acute myocardial infarction and major trauma in terms of the need for: (a) rapid on-scene identification of the life-threatening problem, (b) rapid evacuation and prehospital interventions, (c) rapid pre-notification of appropriate receiving facilities, (d) rapid diagnosis and provision of definitive intervention at those facilities, (e) specialized treatment and evaluation, and (f) appropriate rehabilitation as necessary (6,7). As in the case of the trauma patient, professional responders must promptly begin certain limited interventions and rapidly evacuate the stroke patient to a prealerted specialty center capable of providing definitive interventions. Also, as in the case of a trauma center, experts must be available around the clock, ready to rapidly diagnose the stroke etiology and provide immediate intervention. Furthermore, those stroke specialists must be prepared to deal with the potential complications of their interventions and to evaluate the patient for predisposing or complicating conditions.

However, unlike the clinical scenario of bodily injury, the clinical presentation of stroke is often much more subtle. More importantly, the patient with acute stroke symptoms does not evoke the same level of anxiety or action as the patient with an abdominal gunshot wound. This relative lack of anxiety and responsiveness applies not only to the lay person witnessing the onset of symptoms, but also to the emergency medical personnel responsible for

such patients. Such relatively blunted reactions to stroke patients cannot be thought of as insensitivities or lack of concern on the part of those medical care providers. Their reactions simply reflect the general "state-of-the-art" in current medical education, particularly for emergency medical services (EMS) personnel (8-11).

Up until the present time, acute stroke has largely been considered an unfortunate medical problem requiring only supportive care and monitoring. In turn, with the exception of those experiencing loss of consciousness and/or respiratory compromise, a sense of urgency regarding stroke patients generally has not been conveyed in either the training of 911 dispatchers or the training of responding EMS personnel. Compounding the problem has been the evolution of managed care (primary care screening) as well as sophisticated priority dispatch systems (911 centers) (12,13). Specifically, in some circumstances, dispatchers may purposefully triage and dispatch lesser trained personnel, using a non-emergent response mode (no emergency lights and sirens), when a life-threatening situation is not identified during the telephone in-take (13). In addition, few dispatch centers actually utilize triage algorithms that help to identify and, in turn, prioritize patients with "brain attack." Likewise, the responding EMS personnel have not been routinely trained to identify stroke victims and take them directly (and rapidly) to specific centers capable of providing immediate diagnosis and intervention (as is done in the case of trauma center triage and transportation) (14). In the following pages, the rationale for improved educational initiatives will be detailed, as will issues for further investigation and resolution.

Background

Why There is a Time-Dependent Chain of Recovery for Stroke

Prior to 1995, most of the medical community considered the management of stroke to be largely supportive care. The recently published study of t-PA for acute stroke management, sponsored by the National Institute of Neurological Disorders and Stroke (NINDS), as well as other studies, helped to re-orient the mentality of most practitioners toward the urgency of managing stroke (1-5,15). Even those clinicians who are not entirely convinced about the relative benefit versus risk of t-PA administration within the first few hours after the onset of stroke symptoms have, at least, become more sensitized to the early care of the patient with brain attack (16). The ability to demonstrate enhanced rates of reversal of stroke manifestations clearly created a new paradigm that stroke could be amenable to interventions.

Like acute myocardial infarction (AMI), it was clear that the earlier the intervention, the better the results (4,5,7,17). But unlike the scenario of AMI, alternative procedures to t-PA administration such as direct angioplasty are not yet a key part of the therapeutic regimens available to stroke patients. Thrombolytic therapy, even if provided by more direct and selective catheterization, remains the main therapeutic approach to restoring obstructed blood flow to ischemic

brain tissue. However, unlike the case of AMI, it appears that the longer it takes to provide the therapy, the greater the risk for the serious associated complication of intracerebral bleeding. An informal observation during the NINDS study was that, despite historical information regarding the onset of stroke symptoms, CT scans were generally more predictive in terms of identifying the duration of stroke (4). An accompanying observation was that the later it was in the time course of the stroke, the higher the risk of bleeding complications following thrombolytic therapy.

These observations only serve to underscore the clear need to achieve the earliest possible diagnosis and treatment for stroke. Perhaps the traditional educational concept describing the "golden hour" for achieving definitive trauma care should be more aptly applied to stroke management (6). Likewise, the cardiologists' mantra that "time's muscle" (regarding the salvage of myocardium in AMI) might then be expanded to "time's neurons" for the stroke patient as well.

Another informal observation during the NINDS study was that the control group also appeared to have relatively improved outcomes when compared to historical outcomes, implying a typical "study effect." But it also implies that there may be other benefits for stroke patients (short of thrombolytics) when they receive special attention and rapid supportive treatment. In addition, with the evolution of new neuroprotective agents, the case for rapid identification and intervention may become even stronger (15).

But rapid evacuation to definitive care depends on having a series of sequential, interdependent factors in place in order to optimize the outcome for acute stroke patients. Just as the American Heart Association (AHA) has fostered the concept of a *Chain of Survival* for patients with cardiac arrest, a similar educational metaphor is also befitting for stroke patients (18). In the AHA model, the sequential, interdependent links include *access* (e.g., 911 call); *bystander CPR; early defibrillation;* and *early advanced cardiac life support* (18). If one of the links is missing in this time-dependent situation, survival chances become bleak. A similar chain of survival has been described for trauma patients (6). In the case of stroke, a *Chain of Recovery* may be a more appropriate metaphor in that many untreated patients may survive, but do so with devastating neurological deficits that might have been reversed or ameliorated with earlier intervention. As in the case of cardiac arrest or trauma, it still takes a series of interdependent, sequential events during the emergency phase of care to make the chances of full recovery from stroke possible. As described previously, the key events, representing the emergency phase links in the chain, are (a) identification of the stroke signs and symptoms by the patient or bystanders, (b) immediate EMS system activation and appropriate dispatch with prearrival instructions, (c) rapid EMS response, assessment, evacuation, and appropriate prehospital care, (d) forewarning of the receiving stroke center for resource preparation and mobilization, and (e) rapid definitive diagnosis and treatment by experienced specialists at the stroke center.

If any of these individual links are missing or inadequate, the chances of recovery for the stroke patient may be compromised significantly. For example, if the patient or bystanders fail to recognize the onset of symptoms, care will be significantly delayed even if the dispatchers, EMS responders, and receiving facilities are all performing maximally. Likewise, even with early recognition and rapid EMS system activation, if the patient is taken to a facility incapable of immediately diagnosing and treating the stroke, again the chances of recovery are compromised. In other words, all of the individual links have to be in place and working optimally at all times for each patient.

Why Stroke is a Time-Dependent Challenge for EMS Systems

The need to optimize the efficiency and strength of each link in the *Chain of Recovery* is underscored by the typical time that it takes to get someone to definitive care, even when everything is optimized. Assuming that stroke symptoms are recognized immediately, it still takes a finite time interval (perhaps 5 minutes or so) to recognize the emergency, make the call for help, and confirm the address and "call-back" telephone number for dispatchers. After the minute or two that it takes a dispatcher to prioritize the call and make the actual dispatch, the response interval for first-responders is usually a few minutes. In turn, transport ambulance crews will typically arrive at the scene after another several minutes. After leaving their vehicle, it may take 1 or 2 minutes more for the ambulance crew to reach the patient's side and begin assessment. Therefore, even in the best of EMS systems, professional identification of the stroke may still take 15 minutes or more after the initial recognition of the problem by the patient or bystanders. Aside from the neurological examination and historical assessment, other actions such as general history-taking and vital sign measurements will take several more minutes to accomplish, even when first responders have already obtained most of this information. Following specific actions for stroke patients, such as oxygen application, a more directed historical assessment, and measurement of serum glucose levels (particularly in those with altered mental status), it takes a finite amount of time to transfer and secure a patient onto a stretcher. This scenario also assumes that co-responders are available to simultaneously retrieve the stretcher from the ambulance during the on-scene assessment period. Even with lifting assistance from accompanying responders and assuming that the patient was found on a first-floor location, it would typically take another 5 to 10 minutes to secure a patient into an ambulance. Even if the glucose measurement and more directed assessment were deferred until the ambulance crew departed the scene, the total on-scene time would minimally approach another 10 minutes. More likely, the on-scene interval would be 15 to 20 minutes, even in the most efficient of EMS systems.

The sheer logistics of reaching and retrieving patients, even in a "scoop and run" mode, leads to significant time lapses, a concept often underappreciated by those unfamiliar with the delivery of emergency patient care in the out-of-hospital setting.

In addition to the half-hour interval that it may minimally take, *in the best of circumstances,* to respond to and secure a patient in the back of an ambulance, it typically takes another 5 to 15 minutes to transport a patient to the hospital. Even with the assumption that managed care providers will, in the future, acknowledge the acceptability of transporting the stroke patient to the closest appropriate facility (as they do with trauma centers today), it can be assumed that patient arrival and transfer onto the emergency department stretcher will not take place for at least 30 to 45 minutes after the call for help is first placed into the 911 system. Adding more finite time delays for appropriate establishment of intravenous access, glucose measurements, and cardiac monitoring, prehospital time intervals may be even more protracted. In turn, even with state-of-the-art EMS programs that are already oriented toward rapid identification and transport of stroke patients, the typical time lapse prior to transfer of care to the in-hospital staff can be as much as 1 hour.

Following hospital arrival, it then takes more time to make screening assessments, perform initial procedures (blood work, electrocardiograph, intravenous access), and get the patient to the CT scanner. Therapy will still await the interpretation of the scan (19,20).

In short, assuming that the stroke is identified at its onset and that help is sought immediately, significant and obligatory logistical delays can use up substantial amounts of the time window accepted for thrombolytic therapy. When adding the uncertainty of stroke recognition by the patient (or bystanders), as well as the more typical time delays in calling for help once a problem is identified, one would certainly be pushing the limits of what are arguably the safer temporal windows for thrombolytic therapy. As a result, to date, only a small percentage of stroke patients are considered eligible for therapy. Therefore, the appropriate management of stroke can provide a clear time-dependent challenge for any EMS system. In turn, each EMS system must do whatever it can to strengthen and expedite each link in the *Chain of Recovery* for patients with acute stroke.

Current Inadequacies in the Chain of Recovery

While an initiative to ensure a *Chain of Recovery* for stroke appears to be conceptually plausible, in many communities there are historical, educational, fiscal, and even political obstacles that currently weaken the various links in the chain. More often than not, such weak links lead to complete breaks in the chain of recovery. As described below, these issues may be multifaceted.

Public education still remains the weakest link, particularly in EMS systems which have begun to develop advanced stroke management plans (such as those systems that participated in the recent NINDS study). In turn, this issue of public education is the major focus of another section of this monograph. Likewise, the in-hospital management links are also receiving independent attention (19,20). As a result, the specific focus of this section is to explore ways to strengthen the prehospital links of *dispatch* functions, *prehospital medical care, hospital notification,* and *transport* considerations.

Indeed, when one reviews the currently published training curricula for basic life-support (BLS) responders (e.g., firefighter or police first-responders or basic EMTs) as well as those available for advanced life-support (ALS) providers (e.g., paramedics, flight nurses), one does not yet find didactics that stress the urgency of stroke identification and intervention (8-11). Therefore, it is no surprise that the identification of stroke by EMS personnel is often lacking and that the time intervals to definitive evaluation and treatment are generally prolonged beyond the accepted therapeutic time windows (4,5).

The relatively blunted sense of urgency and responsiveness for stroke patients may also be reinforced by the reception and body language that can be currently observed at many receiving facilities. When the receiving medical staff do not display a sense of urgency regarding stroke patients, EMS personnel are less apt to be as reactive as perhaps they should be in their routines.

On another note, even when identification is made, the specifics of prehospital care and management have not been standardized in a consensus fashion as they have been for cardiac or trauma patients. These issues are particularly important for those patients who must be transported from rural areas or other venues that create difficulties in terms of the patient rapidly reaching definitive care. In the future, studies must be conducted to help determine the relative efficacy of the various potential management strategies to deal with such situations. For example, what is the advisability of providing therapy at a rural community hospital, particularly with the advent of ever-evolving telemedicine technologies or with the potential ability to have specialists rendezvous with the patient at the distant facility (via air medical transport)? Other access-to-care considerations include the advisability of utilizing air medical transport directly from a scene in order to expedite definitive care. Whatever studies are considered, standardized nomenclature and consensus definitions for minimum data sets should be prospectively established, as has been done for cardiac arrest and trauma patients.

To summarize, like weak links in a chain, inadequacies in EMS systems may break the chances for optimal recovery for patients with acute stroke. Even with immediate recognition of stroke onset by family members and the availability of sophisticated stroke centers, a lack of responsiveness and aggressive action on the part of dispatchers or EMS responders can become the weak link that will compromise the time-dependent chances for reversing or ameliorating an acute stroke in evolution. Therefore, it is quite appropriate that EMS system leaders strengthen each link and thus ensure the *Chain of Recovery* for brain attack patients in their communities.

In that respect, considerations should include the advisability of establishing enhanced 911 systems as well as the re-education and re-training of dispatch personnel regarding dispatch life support (DLS) for patients with acute stroke (6,12). Such dispatch-related recommendations should specifically address the feasibility and process of on-line identification and appropriate response triage for stroke patients as well as applicable prearrival instructions (i.e., dispatcher-guided actions

that patients or bystanders can take prior to the arrival of professional responders). The discussions should also address the screening evaluations provided in managed care systems to ensure that stroke patients do not miss a therapeutic window.

Other issues to be addressed should include the training manuals and curricula provided to EMS personnel, both at the BLS and ALS levels. We should focus not only on patient assessment and rapid identification of stroke, but also on standardized patient care guidelines and documentation parameters. In addition, guidelines for the identification and designation of stroke centers as well as the triage criteria for direct transport to such centers should be considered and properly evaluated.

In the end, the distillate of all of these discussions must be targeted at those EMS system educators, supervisors, and medical directors who must eventually stress the urgency of accessing definitive care for patients with brain attack, just as they currently do for patients with abdominal gunshot wounds or those comatose patients with closed head injury. The discussions should also try to analyze and develop empirical guidelines for those extraordinary circumstances in which specialty care is not readily accessible. Simultaneously, with *all* of these discussions, topics for future research and evaluation should be identified and formally addressed by the scientific community.

In conclusion, to optimize the chances of recovery for patients with acute stroke, all of the links in the *Chain of Recovery* for brain attack must be strengthened. The key links include:

1. Immediate identification of stroke symptoms and appropriate reactions by bystanders (or the patients themselves).
2. Early access to EMS (e.g., through enhanced 911 priority dispatch systems that provide prearrival instructions).
3. Rapid EMS response, treatment, and evacuation to designated centers capable of immediately providing definitive diagnosis and treatment of stroke.
4. Early communication to alert the specialty receiving center (by radio or cellular telephone), thereby ensuring preparation and immediate mobilization of resources for the stroke patient.
5. Rapid diagnosis and intervention at those designated receiving centers.
6. Specialized treatment and evaluation of complications, precipitating factors, and accompanying conditions.
7. Appropriate rehabilitation when applicable.

If these links in the *Chain of Recovery* for brain attack are to be established on a widespread basis, it will clearly require a significant number of EMS system modifications for many communities across the United States. Beyond the clear need for public education initiatives, the currently available educational offerings and clinical approaches practiced in most EMS systems indicate that widespread re-education and re-orientation of prehospital care services are now clearly in order if we want to ensure the optimal management of patients with acute stroke.

Consensus Issues

In the following pages, the consensus statements recommended at the National Symposium on Rapid Identification and Treatment of Acute Stroke are presented. The issues addressed were stimulated by the following questions, starting with those related to access and dispatch issues:

1. Should "enhanced" 911 systems be established on a universal basis so that digital displays of the caller's address and telephone number will be entered automatically onto the dispatchers' call screens?

2. Should priority dispatch systems be established and/or upgraded to re-prioritize stroke patients?

3. Should specific dispatch algorithms be established that will help to better identify stroke patients?

4. In tiered systems with ALS and BLS ambulances, should the closest available transport unit (ambulance), basic or advanced, be sent?

5. What type of specialized instructions, provided by dispatchers to those calling for help while EMS rescuers are responding ("prearrival instructions"), should be established for stroke patients? While EMS responders are en route to the scene, should the dispatchers try to ascertain additional information to relay to responding units ("Is the patient a diabetic?" "Did the patient recently fall or have a head injury?" "Is the patient snoring or having problems breathing? "What medicine is the patient taking?")?

6. Should policies be established that will better ensure that stroke patients will not miss windows of therapeutic opportunities because of managed care screening practices?

7. Can the dispatch center and/or medical communications center (EMS base station) receive and promptly provide pre-notification to staff at the receiving facility to prepare them for arrival of the possible stroke patient?

8. What educational initiatives should now be recommended for dispatchers, medical directors for dispatch offices, and EMS managers?

9. How can dispatchers receive feedback regarding stroke patients?

10. What research initiatives are now recommended regarding access and dispatch center activities?

Next, it is also important to address the issue of medical care and transport once the EMS system has been activated. Given the considerations of different EMS configurations and the potential for either ALS or BLS ambulance response (even by design as the closest available transport vehicle), it is important to develop recommendations that are useful for both basic and advanced care providers.

Before presenting specific questions to be addressed, it is important to provide some additional perspectives on this area of discussion. The concept of rapid response and evacuation to specialty centers is not a new

concept for EMS personnel. Both BLS and ALS providers have been well-trained to rapidly transport patients with major injuries directly to trauma centers (6). However, stroke patients have not yet received the same priority and attention, either clinically or educationally. Simply put, an alert, reclining patient with slurred speech, slight facial droop, and a systolic blood pressure of 190 mm Hg generally does not evoke the same call to action that a gunshot wound to the abdomen does. Although we would now want that stroke patient to be approached just as aggressively as the abdominal gunshot wound patient, the concept of similar urgency for stroke patients has not yet percolated into EMS educational programs. Again, if one reviews the current texts and training courses available for both BLS and ALS personnel, it is clear that stroke is not considered an urgent situation short of monitoring the patient for respiratory compromise and providing supportive care for obtundation. At best, EMS personnel are asked to rule out hypoglycemia and to treat it if applicable.

Therefore, to correct the situation, it would be best to target future training initiatives for EMS personnel, both initial and continuing education courses and medical direction. Years ago, the slightly intoxicated 55-year-old man who could calmly point out a powder burn above his umbilicus might not have elicited as much immediate reaction either. However, years of educational efforts, national consensus, and constant reinforcement from quality assurance personnel have helped to establish the clear urgency of such situations. Such efforts have also helped to ensure the rapid evacuation of such patients to specialty (trauma) centers, often bypassing closer hospitals to achieve that goal of rapid definitive care in the hands of experienced experts. In turn, similar educational endeavors should be able to accomplish the same goals for stroke patients.

Given these issues, the symposium participants identified possible problems in the ***prehospital care of stroke patients*** and developed recommendations to deal with the existing weaknesses in the prehospital links of the *Chain of Recovery.* The following questions were addressed:

1. What modifications are necessary to appropriately update current EMS texts and training curricula regarding state-of-the-art stroke management?

2. What types of assessment skills do out-of-hospital BLS and ALS providers, respectively, need to learn and utilize? Which of these skills are mandatory and which are only "nice to know" and utilize?

3. What should first-response personnel (e.g., firefighters and police officers) be taught regarding identification of stroke patients and what actions should they take when dealing with a stroke patient?

4. What prehospital actions and interventions should always be attempted? When should they be aborted or deferred?

5. Under what circumstances should an ALS crew be summoned when a BLS ambulance crew is readily available to transport a patient?

6. Should dextrose be administered (parenterally or orally) for altered mental status without glucose measurement and, if not, should glucometers or reagent strips be recommended as routine equipment for all EMS responders, both basic and advanced?

7. Should hypertension ever be treated in the prehospital setting and, if so, with what therapeutic regimens?

8. What are the recommended airway procedures and under what conditions are they appropriate? What types of oxygen concentrations should be administered?

9. Should moribund (or comatose) patients receive other therapeutic interventions such as mannitol, lidocaine, diuretics, or other agents for reducing intracranial pressure?

10. Should stroke patients ever be provided a dose of aspirin or other antiplatelet agents?

11. Are there any neuroprotective agents that are appropriate for prehospital administration? Are clinical trials indicated?

12. What types of information (including names and phone numbers of witnesses) should be obtained to help more accurately assess the onset of the suspected stroke?

13. Should Neurological Intervention Centers (NICs) be designated and, if so, what would be the proposed triage criteria for recommending direct transport to such centers?

14. What would be the appropriate criteria for initiating early pre-notification of the receiving facility? Would there be various levels of alert depending upon the on-scene assessment of the patient?

15. What kind of feedback loops should be provided for EMS care providers (including dispatchers) regarding their involvement in the *Chain of Recovery* for stroke patients, including their specific management of individual patients as well as specific patient outcomes, particularly when there is a successful outcome as a result of their work?

16. Should model guidelines be developed for patient assessment, management, and hospital notification?

17. What are the educational initiatives that the NINDS should recommend for EMS personnel, their supervisors, their educators, and their medical directors? Should brief public service announcements or educational videos be developed?

18. What are the appropriate areas for research, both administrative and medical? How should educational initiatives be evaluated?

19. What are the appropriate data sets, and particularly the minimal data sets, needed to track and evaluate stroke management? Should stroke registries be established and, if so, what is the appropriate nomenclature for terminology and what are appropriate

prospectively defined data points (e.g., definition of "door to needle time," "EMS response interval," or "EMS transport time")?

20. Should NINDS take a leadership role in terms of developing a model of standardized nomenclature and prospectively defined data points regarding stroke management?

In summary, the number and breadth of these current general questions underscore the need to help strengthen the various links in the prehospital *Chain of Recovery* for the patient with acute stroke.

Special Considerations in Terms of Access to Care and Transportation to Definitive Care

As a final consideration it is important to address special situations outside the realm of most communities where specialty care is readily accessible to the average stroke patient. While the majority of the population lives within urban centers and in relative proximity to tertiary care facilities, access to care becomes a worrisome question once one ventures outside such venues. Small community hospitals traditionally have played a critical role in the initial evaluation and management of stroke patients, but should this role now be changed?

More specifically:

1. Should community hospitals now be bypassed by ambulances? Likewise, if suspected stroke patients arrive at their emergency centers, should community hospital staff members immediately transfer those patients to specialized NICs?

2. Should the staff of community hospitals first attempt to treat stroke patients empirically (or after consultation via telemedicine links)? Should they then transfer such patients? If so, would this paradigm create new training implications for the personnel who would be providing the transfers (i.e., paramedics, flight nurses, etc.)?

3. Should medical rescue helicopters be sent directly to the scene of a stroke patient as is typically done for trauma patients in remote locations? Are there defining criteria for such requests for air medical rescue and what are the circumstances that would contraindicate such a response?

4. Should stroke specialists be flown (or even transported emergently by ground) from specialty centers to the community hospital for evaluation and treatment of stroke patients through prospective practice agreements and contingency plans?

5. Are there feasible areas for research regarding these issues and how could these studies be executed?

In conclusion, patients with acute stroke pose a significant challenge to EMS personnel. From the dispatch office to the neurological intensive care unit and rehabilitation areas at specialized stroke centers, there are multiple links that help to ensure a patient's chance of obtaining full recovery from acute stroke. The strength of that *Chain of Recovery* depends upon the strength of each of the individual links. It is hoped that these discussions will

be a starting point for another major step in achieving the goal of ensuring a strong *Chain of Recovery* for stroke patients. We hope that this goal can be achieved in each and every community and for each and every patient who can benefit from rapid intervention.

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Dispatch Life Support and the Acute Stroke Patient: Making the Right Call

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Introduction

Modern emergency medical services (EMS) priority dispatch systems have evolved from rudimentary call-screening programs to much more sophisticated dispatch centers. Staffed by emergency medical dispatchers (EMDs), these centers often include enhanced 911 emergency telephone systems that identify automatically the telephone number and address of the calling party. They also often include medically appropriate protocols and pre-arrival instructions, computer-assisted dispatch of vehicles, and automatic vehicle locator systems.

Many sophisticated EMS systems are no longer content to send the same kind of equipment, with red lights and sirens (running "hot"), to every call regardless of the nature of the emergency. The goal of the modern dispatch center is "to send the right things to the right people at the right time in the right way and to do the right thing until help arrives" (1). Such centers are capable of meeting that goal with a high degree of accuracy. Curka et al (2) demonstrated that their computerized dispatch center could correctly identify the prehospital patient requiring advanced life-support interventions 97% of the time. It seems reasonable, therefore, that EMS priority dispatch systems would have much to offer the patient experiencing an acute stroke. Indeed, stroke scales and other instruments do exist that can identify the prehospital patient likely to be having an acute stroke (3). These scales, however, are designed to be used by EMS personnel at the patient's side. Such scales could be converted to dispatch protocols. However, the ease and usefulness of such adaptations remain to be seen.

In fact, while there are some areas of promise, there are also many unresolved issues and there are many questions that must be addressed before dispatch systems can send the right things at the right time to the patient having an acute stroke. Some of these issues are reviewed in this discussion.

Public Education

For any EMS dispatch system to have a positive impact on the care of the stroke patient, callers must first understand their role and the importance of early recognition of stroke symptoms. Patients and their families or friends may recognize hemiparesis, aphasia, visual problems, or even sensory losses as symptoms of a stroke. However, denial or a lack of understanding or awareness of stroke symptoms may result in a failure to activate 911 or failure to seek care in a timely fashion.

It is even less likely that 911 will be called for the patient with a posterior circulation stroke presenting only as vertigo, nystagmus, or vomiting. Clearly, further public education is needed regarding the signs, symptoms, and new treatment options for acute stroke.

Access

Even well-motivated and well-educated patients may not receive the maximum benefits of 911 dispatch life support if access to care is difficult or delayed. As of March 1996, approximately 15% of the population of the United States was still using a seven-digit telephone number to call for medical assistance (4). Even communities served by a basic 911 emergency telephone system may not have the advantages of an enhanced 911 system. The automatic identification features of these systems can be very useful for the aphasic stroke patient who is unable to communicate with the EMD. Once 911 has been activated, not all EMS agencies utilize trained EMDs or are equipped with medically approved dispatch protocols and prearrival instructions (2).

In some states and regions, managed care initiatives have led to the development of Resource Management Centers and other mechanisms to prevent patients from accessing 911 before they have been screened by a representative of their payor. Cost-effective medical care is a goal for all patients, including those suffering an acute stroke. However, it is neither cost-effective nor medically sound to deny or delay care for the stroke victim. All emergency triage decisions regarding potential stroke victims are best made using written protocols, under medical supervision, by the EMD. Patients found to be at low risk for an acute stroke or other medical emergency can then be referred to their managed care provider.

Dispatch Center

Even professional, certified EMDs require increased awareness regarding the importance of rapidly recognizing and responding to an acute stroke victim. Standard dispatch texts appear to emphasize that there is no specific prehospital care that will alter the course of a patient's stroke. They do not present stroke as a priority unless the patient presents with an altered level of consciousness or respiratory distress (5). It is logical that the medical and dispatch communities should themselves take stroke more seriously before they can ask the same of the general public.

The evolving designation of a stroke as a brain attack, in terms of its being analogous to a heart attack, has helped both the medical community and the public at large take this entity more seriously. However, the best dispatch protocol and response modes for most EMS systems are unlikely to be the same as those implemented for a myocardial infarction. Instead, prehospital management of the stroke patient ideally should be more similar to the care of the trauma patient.

The challenge and goal is to rapidly and properly identify the patient at risk for an acute stroke and then rapidly transport that patient to an appropriate facility. Proper selection and advanced notification of the receiving facility is also of paramount importance. Unlike the heart attack or cardiac arrest victim, at the present time *prehospital* interventions have little impact on the stroke victim's course. Similar to the care of the trauma victim, prehospital providers can have a profound influence on the patient's outcome by reducing the time required to deliver the patient to definitive care. Indeed, most of the prehospital benefit comes from the ability of the dispatch center to rapidly identify the stroke victim, to quickly send a transport unit, and to get the patient to a facility capable of performing an emergent CT and delivering appropriate treatment as rapidly as possible.

On-line medical control (overseeing physicians in communication via phone or radio) and/or the dispatch center may also have an important role in identifying and notifying appropriate receiving facilities. In addition, they can relay information for inbound ambulances and quickly notify the receiving facility about important information such as the time of onset of symptoms, medications taken, and estimated arrival time of the stroke patient.

Few of the currently available dispatch algorithms are capable of meeting the goal of rapid and accurate identification of the acute stroke victim. As mentioned, most dispatch algorithms give acute stroke a low priority unless the patient has an altered mental status or is in respiratory distress. The patient with a normal level of consciousness but a new hemiplegia, who may be more likely to benefit from aggressive therapy, is given a low priority. New dispatch algorithms that acknowledge the evolving science of stroke recognition and management must be developed with appropriate medical oversight. Because the recent evidence demonstrates that stroke is a time-critical entity, dispatch protocols should strive for the earliest delivery of the patient to an appropriate facility. Medical control physicians should also guide current decision-making regarding dispatch levels. Nevertheless, it must be qualified that upgrading stroke responses to a higher priority or using warning lights and sirens is intuitive, but not necessarily proved as efficacious. We still need to explore whether such modalities explicitly improve patient outcome or time to definitive care.

Priority dispatch systems are often used with tiered EMS systems to select from among a variety of response modes (2). Many EMS systems can choose to send advanced life-support (ALS) or basic life-support (BLS) ambulances, hot or cold, with or without first responders, super-

visors, and even physicians. The exact configuration sent to a stroke victim will depend on the needs and resources of each community as well as the needs of the particular patient. However, the configuration(s) chosen should reflect the current understanding of the importance of rapid transport to a CT scanner and the relative ineffectiveness of prehospital interventions. In many cases, a BLS ambulance with a shorter transport time may be preferable to an ALS ambulance, even though the latter may offer improved assessment and monitoring capabilities en route.

Dispatch Training and Prearrival Instructions

With current training, EMDs are able to identify the stroke victim only 51% of the time (6). A prehospital stroke scale, capable of identifying patients at risk for acute stroke, has been described (3). This scale utilizes information gathered by responding EMS personnel once they arrive at the patient's side, rather than information gathered by the EMD or call-taker. Such a scale potentially could be modified or developed for dispatcher use. There may also be a role for another medic-derived scale, used in conjunction with traditional dispatch information, to facilitate rapid transport and treatment for stroke patients once they have been identified.

Finally, many dispatch centers offer prearrival instructions for such emergencies as childbirth, seizures, and cardiac arrest. Beginning treatment even before the arrival of the field providers is one of the hallmarks of modern dispatch life support. As might be expected, current prearrival instructions for stroke victims are centered around protecting the airway or alleviating respiratory distress. No prearrival instructions are usually available for the majority of stroke patients without such severe symptoms (5). Interventions such as elevating the head of the bed to decrease intracranial pressure or placing the patient in the left lateral decubitus position to minimize aspiration risk may be helpful. Still, it is unclear what interventions, if any, bystanders should be instructed to perform to aid the stroke victim prior to the arrival of EMS. Gathering of medications can be useful as is early identification of certain historical data (such as diabetes, recent head trauma, etc.).

Conclusion

Intuitively, the well-trained and well-equipped EMD certainly can play a valuable role in the care of the stroke patient. However, there still remain many unresolved issues and unanswered questions concerning how best to optimize this role. Summary recommendations regarding these issues can be found in Table 1. While awaiting the necessary further study and implementation of these recommendations, the best way to improve dispatch life support for the stroke patient is to improve public understanding of stroke symptoms and treatment options. In addition, we must ensure access to, availability of, and education for EMDs and EMS providers alike.

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Table 1.
Summary recommendations regarding dispatch life support and care of the stroke patient.

- Public education should be provided on early identification of and rapid action for stroke victims. The public should also be educated on when and how to call for assistance.
- 911 should be universally available and access to 911 should not be restricted by payor organizations. Automatic "enhanced" features should be included in emergency telephone reporting systems.
- EMS dispatchers should be medically supervised and properly trained and equipped. Even for trained and certified EMDs more training on stroke recognition and the importance of early identification and treatment is needed.
- Further study is required, but if there are prearrival instructions or procedures that the EMD can provide, they should be made widely available.
- Under proper medical oversight, dispatch protocols should be developed that recognize an acute stroke as a medical emergency. Appropriate EMS resources for the stroke patient must be identified and dispatched in an expeditious fashion.
- Dispatch and/or medical control should ensure that patients suspected of having an acute stroke are transported to an appropriate facility. They should also ensure that the receiving facility is informed of key information, such as estimated time of patient arrival and the time of symptom onset, so that treatment can be initiated without delay.

Prehospital Identification and Treatment

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Acute stroke is one of the more critical conditions for which patients utilize emergency medical services (EMS). Traditionally, there has not been an emphasis on stroke education for prehospital care providers. Now that proven therapy is available for *some* stroke patients, it is clear that stroke must be treated as an emergency (1). Since the time window for effective treatment is quite short, early identification of the stroke patient by prehospital personnel should help to mobilize emergency department (ED) and in-hospital services. Therefore, prehospital care providers need enhanced education so that they are prepared to quickly identify and possibly treat acute stroke victims.

Where Are We Now?

Knowledge Base

At present, most EMT-Basics are taught very little about stroke. One of the commonly used textbooks for the initial training of the EMT-Basic is *Emergency Care,* 7th edition, by Harvey Grant and colleagues, copyrighted 1995. The primary discussion of stroke is covered in six paragraphs over one column in an 871-page text. The students are advised: "It is not necessary to diagnose the patient's medical problem or to know that a stroke has taken place, although you may suspect it."

This textbook is not alone in its limited discussion about stroke. Table 1 shows the results of a quick survey of other major texts used for the initial training of the EMT-Basic. It is safe to conclude that stroke knowledge among EMT-Basics varies widely.

Paramedics do learn more about stroke than EMT-Basics. One of the major paramedic textbooks is *Paramedic Emergency Care,* 3rd edition, by Bryan Bledsoe, Robert Porter, and Bruce Shade. The discussion of stroke in that book covers about five pages including line art detailing the etiologies of stroke. The differences between ischemic stroke and brain hemorrhage are explained. A list of risk factors for stroke is included as well as a description of the clinical presentation.

Table 1.
Survey of some of the major textbooks for EMT-Basics.

Title	Authors/ Editors	Year Copyrighted	Information About Stroke	Total Pages
AAOS Emergency Care and Transportation of the Sick and Injured, 6th edition	Crosby LA, Lewallen DG	1995	2 sentences	766
The Basic EMT: Comprehensive Prehospital Patient Care	McSwain NE, White RD, Paturas JL, Metcalf WR	1997	Not mentioned	824
Mosby's EMT-Basic Textbook	Stoy WA	1996	Not mentioned	593
Prehospital Emergency Care, 5th edition	Hafen BQ, Karren KJ, Mistovich JJ	1996	8 columns	900

There is a short section on therapy. Students are told to establish and maintain an adequate airway, administer oxygen, and assist ventilation when required. Paramedic students are advised to consider hypoglycemia and to obtain blood for glucose determination. They are further advised to establish an intravenous line with normal saline or lactated Ringer's solution and to monitor the cardiac rhythm. They are instructed to protect paralyzed extremities and provide reassurance to the patient.

Neurological Assessment Skills

Beyond the limited text information, EMS personnel learn little about neurological disorders. The focus of most EMS curricula is to identify changes in mental status, pupillary size, or major motor deficits. Accordingly, the ability to differentiate nontraumatic causes of neurological disease is limited. As EMS is currently practiced, EMT-Basics and paramedics have little reason to differentiate these entities. They do not learn the importance of identifying the time of onset of the event.

Most EMS providers are trained to identify altered mental status. They often have the basic knowledge to identify obvious deficits such as aphasia or hemiplegia, but their ability to identify the etiology of the deficit is limited. The training to assess toxic-metabolic, infectious, neoplastic, or other causes of neurological deficits, with the exception of hypoglycemia, is minimal. A limited amount of material is presented during initial education regarding other central nervous system events (e.g., subarachnoid hemorrhage, hypertensive crisis). These events are relatively rare, and most EMS providers would be unable to differentiate them from various types of ischemic strokes.

Patient Evaluation

Data regarding EMS call volumes indicate that strokes place proportionately small demands on EMS. For example, Cincinnati, Houston, and San Diego Fire Department Dispatch records have indicated that stroke accounted for about 2% of EMS dispatches in 1995. A similar proportion of patients was identified by EMTs or paramedics in the suburban city of Reading, Ohio (2).

In the Reading study, the EMT or paramedic assessment of stroke or transient ischemic attack was correct in 72% of cases (95% confidence interval ranged from 61 to 81%). A wide variety of other disorders mimicked stroke. These included infection/sepsis, syncope, cardiac disease, seizure, drug overdose, brain metastasis, hyponatremia, arthritis, global amnestic syndrome, and radial nerve palsy. The study did not identify stroke/TIA patients who were missed by EMS personnel. So one can conclude that the specificity for the prehospital diagnosis of stroke is about 75%, but there is no information from which one can estimate sensitivity.

EMS units in Reading arrived on the scene a mean of about 3 minutes after the 911 call. On-scene evaluation time was 19 minutes for those patients transported by basic life-support (BLS) ambulance and 24 minutes for those transported by paramedic, or advanced life-support (ALS), ambulance. Patients transported by paramedics were seen by the emergency physician in 10 minutes compared with 20 minutes for those patients transported by BLS. The ALS patients also had CT scans performed 30 minutes sooner than those transported by BLS. The patients transported by ALS had larger neurological deficits. The size of the deficits may have motivated quicker action at the receiving hospital.

Existing data indicate that about half of stroke patients in three metropolitan areas used the EMS system to initiate care for stroke (3). The same database shows that 60% of patients presenting within 90 minutes of symptom onset arrived by EMS.

Mental Status and Hemiparesis

Both EMT-Basics and paramedics learn to assess mental status and are taught to assess the Glasgow-Coma Scale. They also learn to look for findings such as extremity weakness. However, they mainly learn those skills in the setting of assessing the trauma patient.

Limited Differential Diagnosis

Based on the survey of EMT-Basic textbooks described above, it would appear that EMT-Basics learn little about the differential diagnosis of stroke symptoms. Paramedics are taught to recognize stroke. Most EMS systems encourage paramedics to consider hypoglycemia in the differential diagnosis. However, few paramedics are made aware of conditions such as Todd's paresis that can mimic stroke or subdural hematomas that can manifest themselves late (in a nontrauma setting).

Identification of Immediate Life Threats

In general, prehospital emergency care providers do a good job identifying and managing immediate life threats such as severe trauma or cardiac arrest (4,5). Paramedic skills include definitive airway management, treatment of cardiac dysrhythmias, and treatment of seizure activity. However, there is no specific education in most training programs about the life threats faced by the stroke patient.

Therapy

Airway

EMT-Basics learn to manage airways with a variety of minimally invasive tools. They are taught the use of oxygen masks and nasal cannulas. They learn to use nasopharyngeal and oropharyngeal airways and are able to perform suctioning to prevent aspiration. They develop some skill in the use of the bag-valve-mask device to assist ventilations. In a few communities, EMT-Basics are taught endotracheal intubation, although that procedure is usually limited to patients with apnea.

During paramedic training, additional emphasis is placed on endotracheal intubation. Most paramedic training programs emphasize aggressive management of the airway. Paramedics in some areas of North America may utilize nasotracheal intubation. Paramedics in most areas are able to use narcotics or benzodiazapines to facilitate airway management, and in a few areas they may use pharmacologic agents such as succinylcholine to assist intubation.

Hypertension

EMT-Basics are not trained to manage hypertension. Paramedics generally are expected to understand that there are hypertensive emergencies, but they receive limited training in differentiating hypertensive emergencies from acute stroke. In some areas of the country, paramedics carry and administer oral nifedipine for hypertension despite the mounting evidence against the use of this intervention (6). In a very few jurisdictions, paramedics may be able to give sodium nitroprusside or labetalol intravenously. Generally, paramedics are not taught any principles of blood pressure management for the acute stroke patient.

Glucose

Some EMS systems still advocate routine administration of glucose to patients with altered mental status. Although there are no human trials to verify this, evidence from animal trials suggests that administration of glucose to normoglycemic stroke patients may be detrimental (7,8).

Where Should We Be?

Knowledge Base

EMT-Basics are unlikely to be much better informed about stroke than the general public. Therefore we need to expand training in accurate identification and emergency management of the acute stroke patient.

What and How Should EMT-Basics be Taught?

EMT-Basics must learn to recognize the key symptoms of an acute stroke. Studies need to measure the impact of such training on the accuracy of stroke diagnosis by EMT-Basics and paramedics. EMT-Basics should be taught about stroke using the following objectives:

- To gain a better understanding of the etiology of stroke, including the two major types of stroke and the three conditions that cause blockages.
- To describe the biochemical sequence of events that occurs during a stroke and to gain insight into why stroke must be treated within the first 3 to 6 hours.
- To identify the signs and symptoms of stroke and list the common dispatch complaints for stroke.
- To understand the importance of a TIA.
- To obtain and interpret the key vital signs in the stroke patient.
- To determine the time of symptom onset, including asking bystanders when the patient was last at baseline neurological function.
- To perform a simple physical assessment including testing for aphasia ("The sky is blue in Cincinnati"), facial weakness (show teeth), and motor weakness (pronator and arm drift).
- To encourage bystanders or family members to accompany the patient to the hospital so they can provide historical information to the treating team and provide support to the patient. If bystanders cannot go to the hospital, EMT-Basics should obtain a telephone number where they can be contacted.
- To notify receiving hospital about the impending arrival of an acute stroke patient.

Students should practice assessments with an instructor. They should then document their assessment on a large number of patients in the field. Utilization of this type of training program may improve prehospital diagnostic accuracy for stroke.

The real challenge is to integrate this stroke training curriculum into the initial training of the EMT-Basic for which limited time is available. For a variety of reasons, EMT-Basic education is limited to about 110 hours. Therefore, addition of new material, such as identification of acute stroke, will necessitate removal of other material. Deciding what to remove will require additional discussions to gain consensus.

What and How Should Paramedics be Taught?

Paramedics also need to learn skills for the early identification of the stroke patient. Early notification of the receiving ED is an important part of this process. In addition, paramedics need to have a good understanding of the pathophysiology of stroke including the etiology. They need to be aware of the primary risk factors.

Paramedics also need to learn to recognize hypertension in the stroke patient, and literature needs to be developed to support that knowledge. They need to be made aware that thrombolytic therapy is available in hospitals. Paramedics need to understand the mechanism of action of thrombolytic therapy for stroke as well as the indications and contraindications for that treatment so they can accurately advise the receiving hospital of a potentially treatable patient.

They need to be aware of other, still experimental, therapies that may be useful in the early management of the stroke patient. Therapies such as intraarterial thrombolytics might require that some acute stroke patients be transported to hospitals other than the closest available hospital. The development of neuroprotective agents may permit some therapy to be initiated in the prehospital setting (9,10). However, studies still need to be done to demonstrate that such therapy is safe and effective when given before hospital arrival.

Patient Evaluation

History-Taking Skills
EMS providers need to be able to solicit adequate information to accurately differentiate stroke symptoms from other neurological or systemic illnesses. Although these are fundamental skills used in treating all patients, additional knowledge and experience is needed to enhance diagnostic impressions and increase clinical accuracy. It is especially important to obtain the time of onset of the neurological symptoms.

Physical Exam Skills
All EMS providers need to know how to perform a quick physical assessment for stroke. They should learn to test for aphasia or dysphasia and unilateral weakness. They must also learn to differentiate other common causes of stroke symptoms such as hypoglycemia and drug or alcohol intoxication.

Mobilization of Emergency Department Response
It is important for ED physicians and nurses to develop trust in EMT-Basics and paramedics who deliver patients to their hospitals. If the EMS personnel are well-trained and accurate when they state a stroke is present, then the ED nurses and physicians will be more likely to act and have the CT scanner ready when the patient arrives.

It is also important, however, to maintain sensitivity over specificity in the identification of cases. If EMTs are missing too many cases of acute stroke, then a significant proportion of the patients who would potentially benefit will not do so. It will remain important to cast a wide net when identifying stroke patients.

Critical Role of CT Scan
Prehospital caregivers need to understand that the CT scan is critical for accurate differentiation between ischemic and hemorrhagic stroke. EMS personnel can help stroke patients get CT scans quickly by notifying the receiving hospital of a potential stroke patient. This strategy will only be effective if EMS providers are integrated into ED stroke team development so that field activities are reinforced by an appropriate ED response.

Therapy

Airway
EMT-Basics and paramedics should be taught proper management of the airway and attention to brain resuscitation. Much of this skill is already taught in training about head injury. It will be necessary to emphasize that the same principles apply when managing the acute stroke patient.

Hypertension
Paramedics have the knowledge and skills to do close vital sign monitoring. At the present time, there are no outcome data to support the prehospital treatment of increased blood pressure. The only clear indication would be for the treatment of hypertensive crisis, which would require careful assessment and probably the concurrence of an on-line medical control physician. Even in this circumstance, there is no literature to guide selection of an ideal agent.

Most experts in acute stroke management suggest that hypertension should *not* be treated at all in ischemic stroke (11). Some physicians would treat blood pressures higher than 220/120 in *hemorrhagic* stroke. Of course before the CT scan is obtained, the cause of the stroke is unknown. Therefore it would be prudent to recommend watchful waiting as the preferred prehospital treatment for hypertension in the stroke patient.

Neuroprotective Agents
As additional information is gathered about neuroprotective agents, these drugs may have a role in the prehospital management of stroke. Clinical trials are ongoing to learn whether or not these agents are effective. If effectiveness is demonstrated, then the time window will need to be defined so that appropriate recommendations can be written about the role of these agents.

Measurement of Dial-to-Drug Time Interval
EMS providers need to document events in the assessment and management of the stroke patient. This record should include time of onset of the event, time the call for help was received, time that the first EMS unit arrived on the scene, and time that transport to the hospital began and ended.

EMS programs and hospitals need to cooperate in order to minimize the time interval from the initial 911 call to administration of therapy. Just as in the management of acute myocardial infarction, continuous measurement of process variables will drive improvements in stroke therapy. Including the time the telephone was Dialed is important in terms of the data set along with the other "D's" of Door, Data, Decision, and Drug. Cognizance of the five D's will help to make sure that the ED staff have a vested interest in helping EMS improve the emergency management of stroke.

Public Education
An often overlooked component of EMS care is public education. This is true for a wide variety of situations. To varying degrees, most EMS providers offer citizen training in first aid, CPR, and fire and injury prevention. The inclusion of educational materials that help patients recognize and respond quickly and appropriately to stroke symptoms may provide additional major benefit to the community.

Stroke Protocol: EMT-Basic

Historical Findings

- Patient has altered mental status, loss of speech, decreased sensation, or loss of motor function without suspected trauma.
- Patient ***may*** have past history of stroke.

Physical Findings

- Altered mental status. ***May*** range from dizziness to confusion to complete unresponsiveness.
- Speech disturbances—slurred, garbled, or incomprehensible speech or complete loss of speech.
- Weakness or paralysis on ***one*** side of the body.
- Weakness, paralysis, or loss of expression on ***one*** side of the face.

Protocol

- Take body substance isolation precautions.
- Maintain airway and administer oxygen at 2 liters/minute unless respiratory distress is present. Be prepared to assist ventilations. If inadequate breathing occurs, proceed with intubation.
- Place patients with an altered level of consciousness in the left lateral recumbent position with the head and chest elevated.
- Begin transport as quickly as possible.
- If available, request ALS backup when the patient:

  a. is unresponsive, ***or***

  b. has airway compromise.
- Notify the receiving hospital of the projected time of arrival and report the time of onset of the patient's symptoms.
- Perform an ongoing assessment.

Notes

- Patients who experience TIA develop most of the same signs and symptoms as those experiencing a stroke. The signs and symptoms of TIAs can last from minutes up to one day. Thus the patient may initially present with typical signs and symptoms of a stroke, but those findings may progressively resolve. The patient needs to be transported to the hospital for further evaluation.
- Some patients who have had a stroke may be unable to communicate but can understand what is being said around them.
- Place the patient's affected or paralyzed extremity in a secure and safe position during patient movement and transport.
- New therapies for stroke are now available. However, successful use is only possible during a short time window after the start of symptoms. Notifying the receiving hospital promptly and minimizing the scene time are important parts of a strategy to treat patients quickly.

Stroke Protocol: EMT-Paramedic

If paramedics are available, then the following interventions should be considered:

- Maintain airway and administer oxygen at 2 liters/minute. Be prepared to assist ventilations. If inadequate breathing occurs, proceed with intubation. If pulse oximetry is available, administer oxygen as needed to maintain oxygen saturation at (at least) 95% but consider hypoventilation as a possible complication.
- Place patient on a cardiac monitor and document the cardiac rhythm.
- Establish intravenous access with a saline lock or an intravenous line containing normal saline or lactated Ringer's solution to run at a keep-open rate.
- Determine the blood glucose.
- If blood glucose is less than 80 mg/dl, administer 10-25 grams of 50% dextrose slowly (over a minute or two) by intravenous push.
- In general, hypertension in stroke patients should not be treated in the prehospital setting. Observations show that hypertension in stroke patients tends to improve without drug therapy.

Conclusion

Implementation of these recommendations should begin to improve care for the brain attack patient. As additional therapy for stroke is developed, optimal and expeditious prehospital care will help to facilitate effective stroke treatment. Appropriate evaluations should be put in place.

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Special Considerations in Access to Care and Transport

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Introduction

Patients experiencing acute stroke will often receive initial evaluation at hospitals without 24-hour *definitive stroke care** capabilities. The likelihood of this occurring increases in proportion to the distance that the patient is located from a metropolitan area. While timely neurosurgical intervention has been advocated for patients with subarachnoid hemorrhage, there has not been a movement, through public education or changes in prehospital protocols, to direct these patients initially to centers capable of definitive stroke care because they represent only a small portion of patients with change in mental status, headache, stiff neck, or ataxia. Small community hospitals play a critical role in the initial evaluation of these patients, with subsequent triage to centers capable of neurosurgical intervention.

**Defined as a hospital with 24-hour availability of the following: (1) physician with expertise in the diagnosis of stroke; (2) head CT, with assessment by physician with expertise in reading head CTs; (3) ability to treat bleeding complications, including neurosurgical coverage; and (4) emergent ancillary care.*

Recent Developments

The Food and Drug Administration granted approval for the use of t-PA in ischemic stroke in June of 1996. In September of 1996, the American Academy of Neurology published a Practice Advisory (1), which recommends the use of intravenous t-PA for treatment of ischemic stroke within 3 hours of the onset of symptoms. Thrombolytic therapy is not advocated, however, unless: (a) the diagnosis is established by a "physician who has expertise in the diagnosis of stroke"; (b) a head CT is assessed by a physician with expertise in reading head CTs; (c) the treatment facility is readily able to "handle bleeding complications"; and (d) there is adequate emergent ancillary care.

Approaches to Access

Physicians and the general public have a strong desire for more effective methods of treating stroke due to the number of permanent disabilities and deaths that occur each year. While there may be a developing role for the use of intravenous t-PA, it does not appear that there is sufficient data to advocate a universal rerouting of patients (with any potential symptoms of ischemic stroke) only to centers with advanced neurological intervention capabilities. Rather, at the present time, community hospitals will need to play an essential role in the initial evaluation of patients with potential ischemic stroke when centers capable of definitive stroke care are not in the immediate vicinity. In metropolitan areas with multiple hospitals, it would appear appropriate to bring the subset of patients with a high likelihood of stroke preferentially to centers with full neurological intervention capabilities if there are minimal differences in transport times.

Implementation of the following general concepts is best directed at the local level, where there is a full understanding of available hospital and out-of-hospital resources and the best means of their integration.

Access to Care in Communities with Multiple Medical Facilities

Patients who are within 3 hours of onset of loss of strength or sensation on one side of the body should be considered to be time-critical in nature. Emergency medical services personnel should strive to get such patients to definitive stroke care as rapidly as possible. In communities with multiple medical facilities, this may mean bypassing hospitals that are not able to deliver definitive stroke care immediately.

Access to Care in Communities Without Definitive Stroke Care

In communities that do not have facilities that can provide definitive stroke care, the patient with possible acute stroke should be transported expeditiously to the closest emergency care facility. The patient should then be rapidly evaluated and transferred if this can reasonably be expected to improve the chance of a good outcome.[†] When the potential benefits of transfer are uncertain, consultation should be made with a referral center capable of definitive stroke care. Air medical transport may play a critical role in the management of patients who could not otherwise reach definitive care within a therapeutic window if transported by ground. It may also play an important role in managing patients who may not have a specific therapeutic window but have a need to minimize out-of-hospital time because they are dependent on ongoing intervention.

There are no data at the present time regarding the safety or effectiveness of administering t-PA for stroke prior to transfer. The use of t-PA for ischemic

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[†] *For ischemic stroke, this would mean the ability to receive t-PA at the referral center within 3 hours of symptom onset, without contraindications to t-PA therapy.*

stroke may evolve in a fashion similar to the use of thrombolysis for myocardial infarction, in which treatment was administered only in tertiary centers when the treatment was new, but then was moved into community hospitals once more experience and data were gained. Previous controlled trials of thrombolysis for stroke have demonstrated that subtle signs of hemorrhage on CT may be missed with potentially catastrophic results. Future research may determine whether approaches such as focused training modules for community physicians or the use of telemedicine can improve the accuracy of identification of patients appropriate for t-PA therapy. The safety of such treatment prior to the patient's arrival at a center capable of treating the potential bleeding complications must also be investigated. Furthermore, although transport of myocardial infarct patients after thrombolytic therapy has not been noted to result in unanticipated complications, before this approach can be widely advocated the risk of complications secondary to transport itself should be studied in ischemic stroke patients who have received t-PA. Further evaluation is also needed regarding the optimal approach to post-thrombolytic blood pressure management in the out-of-hospital setting.

Access to Care for Patients in Remote Locations

Patients with a high likelihood of ischemic stroke[‡] should be considered for air medical transport directly from the scene if: (a) they are more than 1 hour by ground to the closest hospital, (b) the closest hospital is not capable of definitive stroke care, *and* (c) air transport will get them to a center capable of definitive stroke care within 3 hours of symptom onset. If such patients were to be taken by ground to the closest hospital more than an hour away, it is highly unlikely that they could be transferred to a center capable of definitive stroke care within the therapeutic window.

Reference

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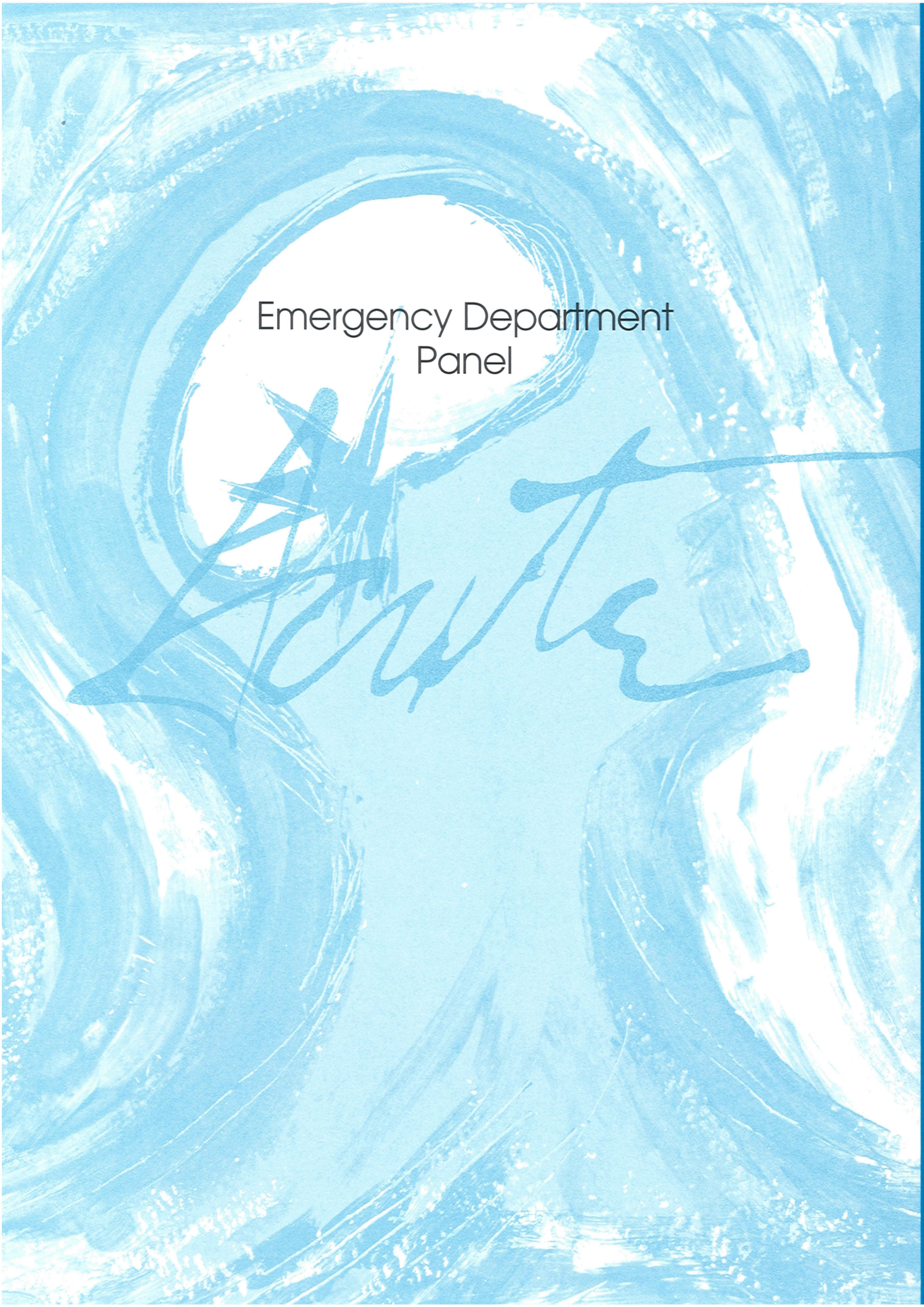
[‡] *Acute onset of loss of strength or sensation on one side of the body.*

Emergency Department Panel



Emergency Department Panel

Overview: Emergency Department

Emergency Department Management of Stroke

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The need for rapid identification and treatment of many disorders including trauma and myocardial infarction has been well documented, and systems have been developed to enable the timely treatment of these disorders (1,2). A cohesive system for the early diagnosis and management of stroke patients has not existed in the past, leading to a sense of therapeutic nihilism for this disorder (3). As emergency treatments for acute ischemic stroke continue to be developed, it will be necessary for institutions to develop a comprehensive plan for evaluation and management. Early treatment cannot be accomplished until we analyze the events surrounding the presentation of stroke, the means by which patients access the health care system, and the process for evaluation and treatment in the emergency department (ED).

The National Heart Attack Alert Program has analyzed the events that occur after the onset of acute myocardial infarction (AMI) in an effort to develop strategies for decreasing the time to treatment. They identified three distinct phases that must occur after onset of symptoms of AMI before treatment can be initiated (4). Phase I is the recognition of the signs and symptoms of AMI and the necessity for action. Phase II is emergency care that takes place after the decision to seek medical care has occurred but before the patient has arrived at the hospital. Phase III is the appropriate emergency care that should occur after arrival at the hospital or emergency center. The same phases can be used to evaluate the care of stroke patients (5). Phase I and Phase II are addressed in other parts of this presentation. This section will deal with Phase III and will attempt to outline our current status in the ED management of acute stroke.

Emergency Department Procedures and Management

There are several critical steps in the ED evaluation of any patient. The patient must first enter the triage and registration process on arrival at the ED (6). For ambulatory patients or those brought in by private car, an interview will take place with a triage nurse, and the nature of the patient's complaint will be elicited.

Along with the history of the present illness, the triage nurse will typically obtain vital signs, a list of medications, and any known drug allergies. Immediately after nurse triage or concomitant with it, the patient will undergo registration. An official medical record will be generated based upon the patient's demographic and insurance information. In most ambulatory patients, registration will take place prior to the patient being placed in an examination room. In patients arriving by ambulance or helicopter, triage and registration will commonly take place in the examination area. Prehospital care providers will typically transport the patient directly into the ED and the patient will be placed in an examination area. Registration information will be obtained either from the patient's family members, prehospital care providers, or at the patient's bedside.

Following triage and registration, the patient will be placed in an examination room. The rapidity of this placement will depend upon bed availability and the nature of the patient's chief complaint. Most EDs will have triage guidelines that dictate which patients may wait until an available treatment area is open. Depending upon the nature of the patient's complaint and triage guidelines, certain standing orders may be initiated by the triage nurse or primary nurse. These would include such items as obtaining an electrocardiogram, intravenous access, supplemental oxygen, laboratory tests, or certain x-rays. For example, a patient with chest pain will typically have an electrocardiogram obtained as part of the triage standing orders. The rapidity with which the patient is seen by the emergency physician will depend upon the assessment of acuity by the triage nurse and the volume and acuity of other patients present in the ED. Most EDs have preset guidelines that dictate which patients require immediate physician notification versus those who will "wait their turn."

After the initial physician evaluation, a differential diagnosis and evaluative plan are formulated. Treatment may also be initiated at this point if the diagnosis is relatively clear and the need for treatment is imminent. Further diagnostic tests will typically be ordered at this juncture. At this point or after diagnostic results are received, consultation with appropriate physicians may or may not be necessary. Most hospital EDs will have protocols developed with different services which dictate when consultation will take place.

Many EDs have developed specific protocols to "jumpstart" the system for the treatment of certain disorders. In Level I trauma centers, pre-notification by prehospital providers will initiate a programmed response by a multidisciplinary team, including trauma surgeons, emergency physicians, respiratory therapists, radiology services, and the blood bank and laboratories (7,8). The trauma victim is typically "met" by this team on presentation to the ED enabling treatment and evaluation to begin immediately. In patients with chest pain, prehospital care providers will often notify the hospital en route and may transmit a 12-lead electrocardiogram (9). When the patient arrives, a room is ready and the evaluation and treatment process can begin without delay.

Current Status of Stroke

Triage and Registration

Triage and registration for the stroke patient will differ depending upon whether the patient arrives by ambulance, helicopter, or private car. There are few data regarding the triage and registration process for ambulatory stroke patients. Special protocols do not exist for the intake of patients with acute stroke, who will typically go through the same process as other ambulatory patients. In one study evaluating stroke patients treated in eight different EDs, the mean time from arrival to triage was 11 minutes including both ambulatory patients and those arriving by ambulance (10). The mean time from arrival to first documentation of vital signs was 7 minutes. The mean time from arrival to lab orders was 48 minutes, suggesting that no standing orders were used for lab ordering by the triage nurse. The American Heart Association has recommended a battery of standard laboratory tests for patients presenting with acute stroke (11). These include a complete blood count, platelet count, prothrombin time, partial thromboplastin time, electrolytes, glucose, and electrocardiogram. Intravenous access, cardiac monitoring, chest radiograph, and supplemental oxygen have also been recommended. There are no data to suggest how many stroke patients arriving at EDs will receive these procedures as part of standing orders.

In patients arriving by ambulance, notification of the ED prior to arrival is recommended (12). In patients with myocardial infarction, prehospital electrocardiogram transmission and pre-notification to the hospital have been shown to decrease the time to treatment with thrombolytic agents from 130 to 81 minutes (13). Data suggest that stroke patients arriving by ambulance will also receive more rapid evaluation by a physician than those arriving by car (10,14). The mode of transport of the patient (advanced life support versus basic life support) will also make a difference in the time of a physician evaluation. Kothari et al demonstrated that patients transported by advanced life-support units were seen by a physician within 10 minutes of arrival at the ED versus 20 minutes if transported by basic life-support units (14). Bratina et al showed that patients arriving by ambulance were examined by the emergency physician within 20 minutes as opposed to 48 minutes for those arriving by car (10). A caveat for pre-notification in stroke patients is the recognition of stroke by the prehospital care providers. In a tiered response system, the diagnosis of stroke by the EMT or paramedic was accurate in 72% of patients (14). However, only 52% of patients with a stroke were recognized by the dispatchers when the call was received.

When the patient is examined by the physician, the diagnosis of stroke appears to be reliable in most cases (15). Kothari et al reviewed 351 patients with a discharge diagnosis of stroke and found that 346 were correctly identified by the emergency physician. Of importance, all patients with intracerebral or subarachnoid hemorrhage were correctly identified by the emergency physicians. The physicians were all in a teaching hospital that had participated in acute stroke studies and may not be representative of all emergency physicians.

In their guidelines for management of patients with acute stroke, the American Heart Association "strongly recommends that emergent CT be the initial brain imaging study" (11). Noncontrast CT is necessary to differentiate ischemic from hemorrhagic stroke and should be done on a priority basis. The time to obtain a CT and interpretation can vary widely. In some cases, CT may not even be performed during the patient's ED stay (10). In one study of five different hospitals, the time from hospital arrival to CT ranged from 50 to 151 minutes with an overall mean of 100 minutes. The time from arrival to CT has also been shown to significantly affect the time to deliver thrombolytic treatment (16). Similar to AMI, pre-notification and arrival by ambulance can lower the time to obtain CT in the ED. Kothari et al (14) demonstrated that patients arriving by advanced life-support units underwent CT within 47 minutes versus 69 minutes for those arriving by basic life-support units.

Once the patient has been evaluated and diagnosed, a neurological consult is often made. The time from patient arrival to consultation with a neurologist has been found to be variable (10,17,18). Bratina et al showed a mean delay of 123 minutes until neurology evaluation (10). Gomez et al documented an average delay of 76 minutes (18). There are data to suggest that outcome is improved when patients are seen early by a neurologist. Davalos et al (17) showed that the relative risk of poor outcome in patients seen by a neurologist later than 6 hours from symptom onset was 5.6. Prompt neurological evaluation correlated with shorter patient stays as well.

The Team Concept

In the care of trauma patients the team approach has been shown to be effective in lowering the time to definitive treatment and decreasing morbidity and mortality. The team approach has also been advocated for care of the stroke patient (12,19). A coordinated approach to the stroke patient has led to decreased time to treatment (16). A stroke team led to decreased time from arrival to triage and arrival to CT, and a higher percentage of patients admitted to an ICU (10). In another study, the stroke team led to earlier arrival of neurological consultation and earlier time to treatment (18). In the absence of a stroke team, treatment for the stroke patient may not be optimal. Blood pressure was often inappropriately treated and excessively lowered and hypotonic glucose-containing fluids were administered frequently (10).

It has been suggested that the team should consist of a neurologist or neurosurgeon with stroke interest and expertise as a team leader (19). In hospitals or areas without readily available neurological expertise, emergency physicians may form the core of the stroke team. Other members of the team should include a nurse or physician extender with neurological expertise, neuroradiology, phlebotomy, and respiratory therapy. The access to the team should be consistent and simple, such as the use of a single paging number which can be accessed similarly to a "Code Blue" or "Trauma Alert" in many hospitals.

The team should develop prehospital protocols for early identification and notification of the receiving hospital. Pre-notification should initiate a response in the ED designed to rapidly evaluate and treat the stroke patient. This would include stroke team activation, early notification of CT prior to patient arrival, standing orders for blood work to be initiated on patient arrival, and evaluation for acute stroke treatment.

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Response System for Patients Presenting with Acute Stroke

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Assuring an appropriate response to patients presenting to the emergency department (ED) with symptoms consistent with acute stroke is paramount in providing efficient, high-quality, cost-effective care for this patient population.

Patients arrive at the ED by private conveyance or are transported by emergency medical services (EMS) personnel. When the ED receives the patient, or receives notification that a patient will be arriving, an assessment must be made as to whether the "stroke team" should be notified. If symptoms suggest the potential for acute interventional treatment, this team should be alerted. Acute interventional treatment should be considered in patients who are found to have cerebellar hemorrhage, lobar intracerebral hemorrhage, subarachnoid hemorrhage, or ischemic stroke.

At a minimum, the stroke team should consist of the physician who will initially evaluate the patient, probably an emergency physician; the emergency nurse who will initially care for the patient; a consulting or admitting physician (neurologist, neurosurgeon, internist, intensivist) who will provide long-term care for the patient; and CT scan personnel (technician and radiologist). Additionally, protocols should be established with the laboratory such that needed studies are processed immediately.

The early notification and timely involvement of key medical personnel is sure to improve patient outcome. Institutions will function differently in this regard. Some will mobilize the entire team through gang beepers. Others will notify individuals one at a time. The key to success will be appropriate communication and a team approach to the care of the patient. This will require meetings and careful preparation prior to the initiation of a stroke protocol or pathway.

Upon arrival in the ED the patient should have the following:

- vital sign monitoring including pulse oximetry; supplemental oxygen should be considered;
- rapid blood glucose level;

- neurological monitoring;
- cardiac monitoring;
- intravenous access established;
- laboratory samples obtained and studies ordered including clotting studies and type and screen;
- head CT scan ordered; and
- electrocardiogram and chest radiograph ordered.

In both treating and studying this patient population it is critical that the initial evaluating physician carefully establish, as closely as possible, the exact time of symptom onset. This often requires repeated inquiry of the patient, friends, or family members. At the present time thrombolytic therapy with t-PA is recommended only within a 3-hour time-frame from onset of symptoms in patients suffering ischemic stroke.

Given that time is an absolutely crucial factor in successful evaluation and treatment of this type of patient, time-frames must be established to guide an institutional response.

- *Door to physician evaluation:* A candidate for acute intervention should have initial physician evaluation within 10 minutes of arrival at the ED.
- *Door to stroke team notification:* Members of the stroke team should be notified within 15 minutes of arrival.
- *Door to CT scan initiation:* The CT scan should be initiated within 25 minutes of arrival.
- *Door to CT scan interpretation:* The CT scan should be interpreted by a capable individual within 45 minutes of arrival.
- *Door to drug (needle) time:* If indicated, the patient should be receiving thrombolysis within 60 minutes of arrival. A threshold of 80% is indicated for this parameter.
- *Door to monitored bed:* The patient should be transferred to the appropriate inpatient setting within 3 hours of arrival.

Educational Needs of Physicians and Nurses in the Emergency Department

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Current Training in Neurological Diseases

The recent FDA approval of t-PA for acute ischemic stroke has ushered in the era of thrombolysis for this condition. The new standard of care resulting from this shift of emphasis is forcing all disciplines involved in the care of stroke patients to reexamine their educational approach for this disease. Emergency personnel will need to reconsider educational efforts from both a content and a process perspective.

Emergency physicians and nurses have a solid understanding of ischemic and hemorrhagic stroke syndromes. Educational curricula in both disciplines include didactic and clinical experience that emphasizes recognition and management of neurological impairment from stroke, intracranial hemorrhage, infection, neoplasm, and metabolic causes. The core content topics that are the basis for emergency medicine residency training in nervous system disorders are listed in Figure 1 (1).

Figure 1. Core content in emergency medicine; acute neurological emergencies.

11.0 NERVOUS SYSTEM DISORDERS
- 11.1 Stroke
  - 11.1.1 Subarachnoid hemorrhage
    - 11.1.1.1 Cerebral aneurysm
    - 11.1.1.2 Arteriovenous malformation
  - 11.1.2 Intracerebral hemorrhage
  - 11.1.3 Ischemic stroke
    - 11.1.3.1 Embolic
    - 11.1.3.2 Thrombotic
  - 11.1.4 Transient ischemic attack

The topics are a simple listing of disease categories without subordinate details. Curricula are developed from this list by program directors, and these subjects are covered in emergency medicine training through a combination of clinical and didactic education. However, a sense of futility has accompanied education on acute stroke. Patients might be expected

to improve but do so largely independent of therapeutic intervention. Excluding stroke patients with operative intracranial lesions, the medical task in the past was to support physiologic functions, prevent complications (e.g., pneumonia, bed sores), and hope for the best.

Emergency Department Management of Stroke Victims

As in most emergencies, the diagnostic and management urgencies in patients with stroke are determined by the degree of actual or anticipated impairment of basic physiologic functioning. Patients with obviously impaired respiratory, hematological, or neurological function are treated with the highest dispatch. Airway, breathing, and circulation are restored and stabilized with impressive efficiency in today's emergency departments (EDs). Accordingly, the stroke patient who is cyanotic, severely hypotensive or hypertensive, or comatose receives immediate intervention to restore vital functions. Diagnostic efforts and therapeutic decisions are usually expedited under these extreme conditions. In contrast, the quietly hemiparetic stroke victim may receive an entirely different treatment regimen. In most EDs a stable respiratory and circulatory status often relegates a patient to an intermediate or lower level of urgency. Detailed and lengthy neurological examination is often carried out before diagnostic studies are considered. Once ordered, head CT of the stable stroke patient may be delayed because other ED patients are given higher priority.

Educational Needs of Emergency Physicians and Nurses

The low priority given to acute treatment of stroke victims is an outgrowth of a frustrating period for modern medicine characterized by abundant research but little progress in the quest for a therapeutic breakthrough. A paradoxical situation now exists where the victims who might gain the most from aggressive diagnostic and therapeutic interventions are left alone to silently extend their damage while others, who have poorer prognoses and less to gain, are given the benefit of expedited care. The demonstrations that selected stroke patients can benefit from thrombolysis will put a new complexion on our approach to these patients. Along with the new approach will come an additional responsibility for emergency nurses and physicians to be cognizant of the subtle distinctions between stroke patients who might benefit from thrombolysis and those who might suffer serious harm. Eligible patient identification will be difficult. Rapid neurological assessment must be taught to triage nurses and physicians so stroke patients are identified rapidly for streamlined care. The implementation of the therapy will present yet another challenge. The whole process will be the subject of retrospective scrutiny as expected complications occur in appropriately treated patients and our experience increases.

Table 1.
Comparison of thrombolysis in stroke and myocardial infarction.

Factors	Stroke	Acute Myocardial Infarction
Time	Critical	Critical
Symptom	Variable neurological deficit	Chest pain
Patient identification	Complex	Straightforward
Diagnostic standard	CT scan	Electrocardiogram
Blood pressure	Exclusionary, critical range	Exclusionary, critical range
t-PA	0.9 mg/kg (10% bolus followed by 90% over 60 mins)	100 mg (15-mg bolus followed by 85-mg infusion over 90 mins)
Benefit	Long-term outcome improvement	Short- and long-term outcome improvement
Most severe complication	Intracranial hemorrhage, death	Intracranial hemorrhage, death
Recanalization	Up to 60%	Up to 60%
Risk	6.5% intracranial hemorrhage	< 2% intracranial hemorrhage

Urgency of Care

Although it is never difficult to persuade emergency personnel that time is a critical element for successful intervention in an acute disease, they will now need to understand exactly how critical it is for patients suffering ischemic stroke. Extrapolation of ED experience with thrombolysis in acute myocardial infarction will facilitate this. Our successful experience with acute myocardial infarction will also help overcome system inertia and increase appreciation that established methods to expedite selected patients can be very successful. Table 1 lists key similarities and distinctions between thrombolytic therapy for acute ischemic stroke and myocardial infarction (2-4). The highly variable clinical presentation of acute stroke increases the complexity of the clinical problem.

The new urgency being brought to this disease process by the possibility of successful early therapy also helps to create categories of educational needs for emer-

gency personnel. A more in-depth understanding of the pathophysiology of the disease process is only part of the educational challenge. An understanding of the treatment risks and complications forces attention to the process of care. Both nursing and physician personnel will need to understand the importance of timing, blood pressure control, and careful neurological and cardiovascular monitoring throughout the therapeutic process. Figures 2 and 3 list suggested pathophysiological and procedural content of educational programs for emergency personnel.

Figure 2. Pathophysiological topics.

Pathophysiological Education — The Why

1. **Natural history of stroke**
   a. Time factors in neuronal death
2. **Patient identification**
3. **Thrombolysis in stroke**
   a. Differences from coronary
   b. Indications
   c. Potential benefit
   d. Complications
4. **Other acute interventional treatments**
   a. Neuroradiological
   b. Neurosurgical
5. **Computerized tomography interpretation**
   a. Subtle findings and impact on therapeutic decision-making
6. **Blood pressure requirements**
   a. Impact on complications and outcome
   b. Acceptable interventions in the stroke patient
7. **Outcome modification**

Frequency Considerations in Emergency Personnel Education

Common sense tells us that frequency is an important consideration when planning educational activities in any clinical situation. Staff awareness of clinical procedures, their comfort level with management protocol execution, and overall quality of care improve when they are exposed to a clinical situation more frequently. The practiced response that develops among team members improves as unanticipated glitches are worked out of the system. Details become incorporated into memory and efficiency improves. Conversely, uncommonly executed protocols are more sluggishly applied as details need to be reviewed each time.

Figure 3. Process topics.

Procedural Education — The How

1. **Patient identification**
2. **Efficient neurological examination**
3. **Communication protocols**
4. **Stroke team**
5. **Essential tests**
   a. Computerized tomography of head
   b. Laboratory
      i. CBC, differential
      ii. Electrolytes, BUN, creatinine
      iii. Prothrombin and partial thromboplastin times
      iv. Pregnancy test if indicated
   c. Chest radiograph
   d. Electrocardiogram
6. **Desirable imaging**
   a. Cardiac ultrasound for effusion
   b. Abdominal ultrasound for aortic aneurysm
7. **Monitoring requirements, type and frequency**
   a. Cardiovascular
   b. Neurological reassessment
8. **Quality assurance**
   a. Time standards

The need for staff refresher courses for skill maintenance increases in low-frequency states. The frequency factor is an important consideration when planning clinical educational activities.

Stroke is only one-third as common in our population as acute myocardial infarction. Each year there are 500,000 (80% ischemic) acute strokes in the United States and 1,500,000 acute myocardial infarctions, so in general practice an emergency team will see only one stroke patient for every three acute myocardial infarction patients (2). Only a small percentage of the stroke patients will be eligible for thrombolysis treatment but all will benefit from more expeditious treatment. Nevertheless, skillful application of a complex selection process and rapid execution within a tight time-frame will be required on an infrequent basis. The educational challenge to maintain such a state of readiness will be significant.

Educational Approach

A high state of motivation can be attained and maintained in emergency staff by consistently accentuating the positive in our stroke management experience. Case conferences covering patient experience need to involve all members of the interdisciplinary team. Regularly updated reports of experience with stroke patients should be circulated to those involved. Successes need to be given much attention to create a sense of group gratification over the benefit afforded to victims of stroke from the diligent teamwork.

The low-frequency exposure expected for ischemic stroke patients eligible for thrombolysis calls for special efforts to keep a high level of awareness of the treatment initiative. Posters, people, and perseverance will be needed. ***Posters*** reminding staff of the need should be placed in lounges and work areas in EDs. The ***people*** in the multidisciplinary team need to attend conferences and receive in-service training and ongoing encouragement. The initial push to educate all must be followed by ***perseverance*** in reminding the team of the ongoing need. Complacency that all are in a state of readiness will not last long if 2 months go by without an eligible stroke patient.

Although a positive outlook must be maintained, recognition of the limitations of therapy must also be recognized in order to avoid a backlash due to disappointment with adverse outcomes. Emergency nurses and physicians need to thoroughly understand the likelihood that some patients will suffer intracranial hemorrhage after receiving thrombolysis. If this downside is not placed in proper perspective, it could threaten to undermine the effort to recruit patients in the critical timely fashion that is necessary to limit this complication.

Strategy for Change

Changing the standard of care for stroke patients will be a process of communication and education. Identification of stakeholders needing to understand and support the change will be critical to the success of the effort. Emergency physicians and nurses are the focus of this section of the report. Among physicians and nurses

there exist subcategories of those currently practicing and those in training. The practicing group will need support in the form of continuing education activities covering the areas identified earlier. Nurses and physicians in training will require a shift in emphasis of their curricular activities dealing with stroke. The practicing group will require coordination with professional organizations representing the nursing groups. The second group will require graduate medical education training programs through nursing and medical schools. The most immediate task is to change the practice through communication and educational efforts in the clinical areas. The curriculum review processes of the educational institutions will incorporate the change in standards occurring in the community.

Summary: Educational Needs

The multidisciplinary needs of the acute stroke victim mirror the needs of multiply injured patients and acute myocardial infarction patients. Delivery of acute resuscitation, definitive diagnosis, and therapeutic measures within the narrow time window for effective therapy will require coordinated action. Educational activities will need to involve the patient and all who have an impact on care from the time of the event until recovery. The role of the ED—identifying patients, providing early care, and mobilizing resources to definitively manage the disease for optimum outcome—will be critical to success. This will require a shift in attitude and educational emphasis toward emergency management of acute stroke victims.

Current attitudes toward stroke victims need to be shifted using persuasive evidence of need. Institutions treating stroke victims need to establish multidisciplinary working teams to accomplish the task. Emergency physicians and nurses must be educated to perform sophisticated selection of stroke victims for thrombolysis. Efficient communication and coordination of functions need to be practiced. Educational efforts must be tailored both to practicing physicians and nurses and to students. An encouraging approach that accentuates the positive while recognizing limitations will yield the best results. A state of readiness for the low-frequency patient can be maintained with an approach using posters, people, and perseverance promoting the need to act quickly to optimize results.

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Guidelines for Medical Care and Treatment of Blood Pressure in Patients with Acute Stroke

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Guidelines for medical care of stroke patients have been recently published by the American Heart Association (1). Treatment guidelines for patients with acute stroke include oxygen as well as treatment of concomitant congestive heart failure, arrhythmia, hyperglycemia, and elevated body temperature. Even though these recommendations are not based on data from controlled randomized trials, all of these treatments are safe, potentially helpful, and noncontroversial.

Treatment of blood pressure in acute stroke, however, is more controversial and is the focus of this paper. There are no randomized trials that provide data to support guidelines for treatment of blood pressure in acute stroke patients (1–3). Previous guidelines have been based on clinical observations, clinical studies of the autoregulation of cerebral blood flow in humans and animals, animal models of acute stroke, and current concepts concerning the pathophysiology of focal brain ischemia. Most recent guidelines have recommended minimal or no initial treatment of mild to moderately elevated blood pressure during the first several hours in patients with ischemic stroke (1–3) but more aggressive treatment of elevated blood pressure in patients with intracerebral or subarachnoid hemorrhage (1,4,5). Guidelines for treatment of elevated blood pressure in the setting of thrombolytic therapy for acute ischemic stroke are lacking.

Ischemic Stroke

Minimal or no treatment of mildly to moderately elevated blood pressure during the first hours of ischemic stroke is supported by human and animal data. Because of the partial or complete loss of autoregulation in ischemic brain, cerebral blood flow in these regions depends almost entirely on the arterial blood pressure to maintain cerebral perfusion (6-8). The majority of patients who have an ischemic stroke have a history of hypertension with a higher baseline arterial blood pressure as well as a higher and more narrow range of autoregulation of cerebral blood flow (6,7). Most patients with ischemic stroke who

have elevated blood pressure during the first several hours after stroke onset have a spontaneous decline in elevated blood pressure without antihypertensive medication (9). Thus, lowering of elevated blood pressure to normotensive levels in ischemic stroke patients may exacerbate brain ischemia and result in poorer patient outcome, particularly in previously hypertensive patients (1,6).

None of the animal or clinical studies convincingly support treatment of mild to moderately elevated blood pressure in patients with ischemic stroke. Supportive studies for treatment of elevated blood pressure in ischemic stroke are limited to animal models of induced severe hypertension in the setting of focal cerebral ischemia (10) and clinical studies of hypertensive emergencies. Excessive levels of hypertension can lead to disruption of the blood-brain barrier with resultant edema and brain injury in animal models of focal brain ischemia (11-13). In addition, pharmacologic lowering of elevated blood pressure is recommended in patients with ischemic stroke who have a suspected aortic dissection or myocardial infarction to avoid worsening these conditions.

Guidelines for treatment of blood pressure in the setting of ischemic stroke have been proposed and are listed in Table 1. The agents used to treat elevated blood pressure should be easily titratable with a quick onset of action but with a limited risk of excessive and sudden lowering of blood pressure. Preferred agents include low doses of intravenous labetalol or low doses of enalapril. Some investigators have also used small patches of nitropaste. More aggressive, but also easily titratable, treatment of blood pressure includes continuous intravenous infusions of nitroglycerin, nitroprusside, or esmolol. Sublingual nifedipine is one of the most commonly used agents to lower blood pressure in the emergency department. However, it should be viewed as second-line therapy since its effect may be delayed, it is more difficult to titrate as compared to the intravenous medications, and its use can be associated with precipitous drops in blood pressure (14). If blood pressure is lowered in this setting, serial neurological examinations should look for signs of deterioration such as increasing weakness or a reduced level of consciousness. The presence of these findings should prompt consideration of more conservative control of blood pressure.

The approval of t-PA for the treatment of acute ischemic stroke complicates management of elevated blood pressure in stroke patients. In the randomized NINDS t-PA Stroke Study (15), patients were excluded from treatment with t-PA if their blood pressure was greater than 185 mm Hg systolic or 110 mm Hg diastolic or required aggressive treatment to reach these limits. The rationale for these blood pressure limits derived from the association of baseline elevated blood pressure and subsequent intracranial hemorrhage in the myocardial infarction studies of t-PA as well as the pilot NINDS study of t-PA in acute stroke. Aggressive treatment was not specifically defined prospectively in the protocol of the NINDS randomized study but was

Table 1.
Algorithm for emergency treatment of blood pressure in patients with ischemic stroke.

1. Blood pressure obtained by automatic sphygmomanometer should be correlated with a manual blood pressure cuff reading.

2. If diastolic blood pressure > 140 mm Hg occurs on two readings 5 minutes apart, then start a continuous IV infusion of an antihypertensive agent such as sodium nitroprusside (0.5-1.0 mg/kg/min). Patients who fall into this category are not candidates for t-PA therapy even if other inclusion criteria are met.

3. If systolic blood pressure is > 220 mm Hg or diastolic blood pressure is 121-140 mm Hg or mean arterial blood pressure is > 130 mm Hg on two readings 20 minutes apart, then give an easily titratable antihypertensive medication such as labetalol at 10 mg IV over 1-2 minutes. The labetalol dose may be repeated or doubled every 10-20 minutes until a cumulative dose of 300 mg has been administered via this mini-bolus technique. After the initial dosing schedule, labetalol doses may be administered every 6-8 hours as needed. Labetalol is usually avoided in patients with asthma, cardiac failure, or severe cardiac conduction abnormalities. Enalapril (1.25 mg over 5 minutes and repeated every 6 hours or as needed) is an acceptable alternative, particularly in patients with congestive heart failure. Consider starting with 0.625 mg over 5 minutes in the elderly. IV esmolol or small patches of nitropaste are other options. Patients who require more than two doses of labetalol or other antihypertensive agents to decrease blood pressure to < 185 mm Hg systolic or 110 mm Hg diastolic are generally not candidates for thrombolytic therapy even if other criteria are met.

4. If systolic blood pressure is 185-220 mm Hg or diastolic blood pressure is 105-120 mm Hg, emergency therapy should be deferred in the absence of left ventricular failure, aortic dissection, or acute myocardial ischemia. Patients who are potential candidates for t-PA therapy but who have persistent elevations in systolic blood pressure of > 185 mm Hg or diastolic pressure of > 110 mm Hg may be treated with small doses of IV antihypertensive medication to maintain the blood pressure just below these limits. However, more than two doses of an antihypertensive agent to lower the blood pressure below these limits is a relative contraindication for thrombolytic therapy and should be discouraged.

5. If blood pressure is lowered by antihypertensive agents in the setting of acute stroke, serial neurological examinations should be performed to look for signs of deterioration such as increasing weakness or reduced level of consciousness.

6. In acute stroke patients with systolic blood pressure < 185 mm Hg or diastolic blood pressure < 105 mm Hg, antihypertensive therapy is usually not indicated.

7. Although there are no data to support a threshold for treatment of hypotension in stroke patients, we recommend treatment for signs of dehydration, blood pressure that is substantially below the expected level for a given patient (consider past history of hypertension, treated or untreated), or both. Therapeutic options should include IV fluids, treatment of congestive heart failure and bradycardia, and consideration of pressor agents such as dopamine.

thought to include intravenous nitroprusside or repeated doses of labetalol, enalapril, or nifedipine. In addition, elevated arterial blood pressure was closely monitored and treated during the first 24 hours. Patients who had persistent elevations in systolic blood pressure of greater than 185 mm Hg or diastolic pressures of greater than 105 mm Hg were generally treated with small doses of intravenous antihypertensive medication to maintain the blood pressure just below these limits. Thus, treatment of elevated blood pressure in acute ischemic stroke in the setting of the NINDS t-PA Stroke Study differed slightly from guidelines for ischemic stroke patients in general (Table 1). It is likely that these guidelines will evolve as additional randomized studies of thrombolytic therapy are completed.

Although the focus of this paper is treatment of elevated blood pressure, proper treatment of low blood pressure in the setting of acute ischemic stroke is equally important (Table 1). Low blood pressure in an elderly stroke patient may reflect dehydration, arrhythmia, or diminished cardiac output. Treatment considerations should include intravenous boluses of normal saline, treatment of severe bradycardia with atropine, or slowing of rapid atrial fibrillation with digoxin or a calcium channel blocker. If these maneuvers are ineffective in raising the blood pressure, consideration should be given to pressor agents such as dopamine, if not contraindicated.

Intracerebral Hemorrhage

Control of elevated blood pressure has never been shown to decrease the risk of ongoing or recurrent bleeding in patients with intracerebral hemorrhage (4). Nonetheless, we recommend treatment of moderate and severe elevations of blood pressure (systolic blood pressure of greater than 180 mm Hg or mean arterial pressure of greater than 130 mm Hg). The goal of treatment should be to lower the blood pressure to a mean arterial pressure of 100-130 mm Hg or to the low hypertensive range (e.g., systolic pressure of 140-160 mm Hg). Lower blood pressures may be poorly tolerated because the cerebral perfusion pressure (CPP) is dependent on the intracranial pressure (ICP) as well as the arterial blood pressure (ABP): (CPP = ABP – ICP). High levels of ICP require higher blood pressures to maintain a stable CPP. If an ICP monitor is in place, the goal should be to maintain the CPP at 70-100 mm Hg (4).

The antihypertensive medication should be an agent that is quick in onset and whose effect is easily titratable. Intravenous labetalol is an excellent choice for moderate levels of elevated blood pressure because it is fast-acting, titratable, and has no known adverse effect on either ICP or autoregulation of local cerebral flow. Intravenous enalapril is also an excellent choice because it has no known effect on ICP or autoregulation. For more severe elevations (e.g., diastolic pressures greater than 130 mm Hg) nitroprusside is recommended. Theoretically, nitroprusside can increase ICP because it is a cerebral arterial vasodilator. However,

this potential negative effect has not been demonstrated in clinical use. Nitroprusside has the advantage of being the easiest medication to titrate. Calcium channel blockers, such as sublingual nifedipine, are less predictable, slower in onset, and can dilate cerebral arteries. They should be employed only as a second-line medication when the other medications cannot be used.

Subarachnoid Hemorrhage

The treatment of blood pressure in patients with subarachnoid hemorrhage is controversial (5). In addition, management of blood pressure depends upon the timing of treatment as well as the status of aneurysm clipping. For example, prior to operative clipping of the ruptured aneurysm, elevated blood pressure is usually pharmacologically lowered to decrease the risk of rebleeding from the cerebral aneurysm. Yet no study has shown that treatment of elevated blood pressure reduces the risk of rebleeding. After clipping of the aneurysm, patients are often treated with induced hypervolemia and hypertension to decrease the ischemia associated with vasospasm.

Oral nimodipine is given at a dose of 60 mg every 4 hours orally or through a nasogastric tube to decrease the morbidity associated with vasospasm and subsequent brain ischemia. This agent will result in mild lowering of blood pressure. However, if blood pressure remains elevated prior to clipping of the ruptured aneurysm, despite treatment with nimodipine, we recommend treatment of elevated blood pressure as per the guidelines for intracerebral hemorrhage.

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Classification System for Stroke Patients

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Overview

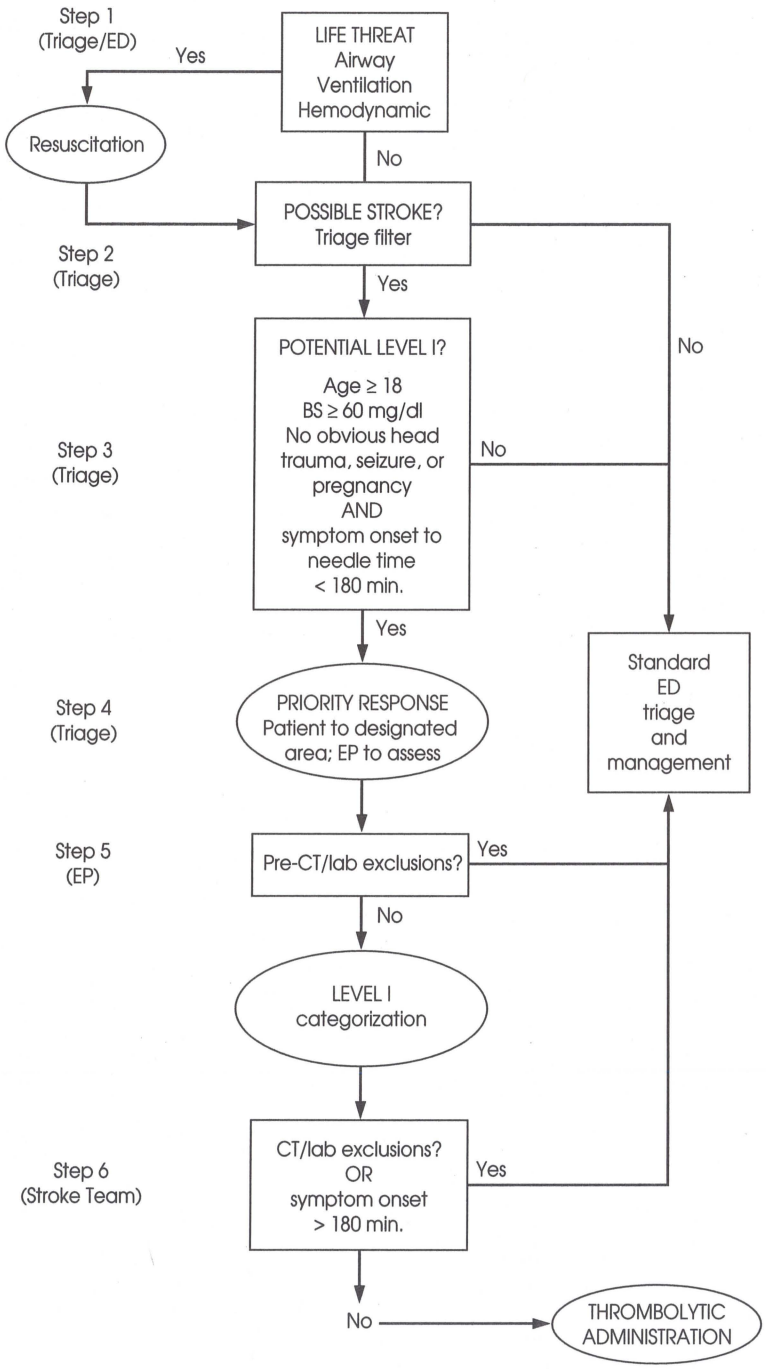
The primary intent of emergency department (ED) stroke classification is the expedient identification of those patients who require acute interventional therapy. Such therapy includes the resuscitation of patients presenting with cardiopulmonary life threats, prompt recognition and care of stroke and nonstroke emergencies, and the delivery of thrombolytics to selected stroke patients who satisfy strict inclusion criteria.

More specifically, the proposed categorization system (Figure 1) will distinguish those patients who could receive t-PA from those who should not. This should render the most efficient utilization of ED and hospital resources including the optimal deployment of key personnel. The approach is analogous to that developed for the subset of chest pain patients who warrant thrombolysis.

Categorization Principles

Patients are assessed for the presence of life-threatening conditions and managed accordingly (step 1) prior to or coincident with categorization for stroke. The categorization system relies first upon a simple, rapid, and sensitive filter during triage to identify all possible stroke patients (step 2). Elementary parameters are then tested (step 3). If these are satisfied, the triage health care provider (HCP) institutes a *priority response* (step 4), including notification of the senior emergency physician (EP). The EP then administers rigid and specific pre-CT and laboratory criteria via history and physical examination (step 5). If these are met, the patient receives Level I categorization. Requisite laboratory tests are obtained, the patient is delivered expeditiously to the CT suite, and the stroke team is notified. If, following review of the CT scan and laboratory tests, no exclusions exist and the time from symptom onset is less than 180 minutes (step 6), t-PA may be administered.

Figure 1. Proposed system for identifying patients eligible for t-PA treatment.



The categorization sequence can be applied entirely in the ED or initiated in a variety of other health care locales. Depending on the acuity of the patient's condition and clinical circumstances, steps 1, 2, 3, and 4 may be carried out by a prehospital care provider, triage nurse, bedside nurse, EP or other physician, or some combination. These same steps may transpire in a transferring institution, prehospital transport vehicle, triage station, or at the bedside in the ED. Therefore, a patient who has been processed successfully through certain of these steps prior to arrival at the receiving ED should be inserted into the algorithm at the appropriate juncture.

This categorization schema is deliberately simplistic and not intended to specify the management of many other emergent neurological and non-neurological diseases that may be discovered in the process. Patients who are directed toward "Standard ED Triage and Management" in this algorithm are expected to receive a high standard of care dictated by their condition.

Step 1—Triage/ED

Identification and Management of Life Threats
Patients with exigent airway, ventilatory, or hemodynamic concerns receive resuscitative measures. Many of these patients will not be eligible for thrombolytics.

Step 2—Triage

Identification of Possible Stroke Patient
The triage HCP should utilize historical information obtained from prehospital care providers, the patient, and the patient's family or friends. This is coupled with a simple examination to determine whether a measurable neurological deficit exists.

Step 3—Triage

Identification of Potential Level I Patient
The patient must be at least 18 years of age and have a triage fingerstick blood glucose greater than 60 mg/dl. Obvious head trauma, seizure, or pregnancy precludes the patient from further consideration for t-PA. Candidates for thrombolysis must be able to be processed within 180 minutes (interval from symptom onset to needle time). This processing time will vary among institutions.

Step 4—Triage

Priority Response
The triage HCP ensures prompt delivery of the patient to a specified treatment area in the ED and notification of the department's designated EP of a potential Level I patient.

Step 5—EP

Pre-CT and Laboratory Exclusions
The EP applies a rigorous history and physical examination, including the NIH Stroke Scale, in determining whether the patient should be assigned Level I status. Level I categorization implies that requisite laboratory tests and CT be obtained immediately and that the stroke team be notified of the presence of a Level I patient.

Step 6—Stroke Team

CT and Laboratory Exclusions
The stroke team assiduously reviews the CT and laboratory data. If all inclusion criteria are satisfied, all exclusion criteria have been eliminated, and the time elapsed from symptom onset is less than 180 minutes, t-PA is administered in the ED or other designated area.

Emergency Department Approach to Outcome Analysis

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The emergency department (ED) plays a central role in the rapid identification and management of patients with acute stroke. In general, there is consensus that early recognition and appropriate intervention will lead to better patient outcome. At the present time, however, many EDs do not have mechanisms in place to efficiently and effectively manage stroke patients. Furthermore, very few hospitals have established appropriate indicators to monitor the quality of acute stroke care in the ED. While these indicators will vary somewhat depending on the characteristics of the facility, each hospital should develop the ability to monitor several key items in the continuum of care within the ED that directly affect the quality of care for patients with acute stroke.

Examples of items to monitor include issues related to time, morbidity, and mortality. Since early treatment is the cornerstone of effective stroke management, monitoring the following time periods will help improve the speed of movement through the ED:

1. Door to physician evaluation
2. Door to CT table
3. Door to needle (for patients receiving intravenous t-PA)

Monitoring requirements for morbidity and mortality could include:

1. Symptomatic intracerebral hemorrhage within 36 hours of receiving thrombolytic therapy.
2. Adherence to the selection criteria and management guidelines for the use of intravenous t-PA.
3. Functional status at 3 months, discharge level of disability, or death, subdivided into ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage etiologic groups.

Acute Hospital Care Panel

Acute Hospital Care Panel

Overview: Acute Hospital Care

Hospital Care of Acute Stroke

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Delivery systems for acute stroke hospital care are relatively primitive compared to systems for state-of-the-art emergency cardiac care. In part, this reflects the nihilistic attitude toward acute stroke care fostered by years of providing only supportive therapy (1). The recent approval of intravenous t-PA for selected patients with ischemic stroke of less than 3 hours' duration has exposed these deficiencies and mandates changes in the hospital care system. Importantly, although the immediate impetus stems from thrombolysis and brain ischemia, these long-delayed changes in hospital stroke care will also benefit patients with subarachnoid and intracerebral hemorrhage.

Pertinent to acute stroke intervention are aggressive stroke teams with a paging and response algorithm modeled after the "Code Blue" concept used in acute myocardial infarction (AMI) (2,3). Pilot studies using stroke teams have been conducted in tertiary centers, usually related to clinical trials, with dramatic reductions in diagnostic and treatment delays (4-6). However, it probably will not be feasible to develop comprehensive acute stroke teams in many community hospitals. Some hospitals may not be equipped to care for more severe or complex stroke patients, for example those with intracerebral or subarachnoid hemorrhage. Availability of neurologists, neurosurgeons, interventional neuroradiologists, and other specialists may be limited in outlying regions.

Comprehensive regional stroke centers for patients with complex, resource-intensive cerebrovascular disorders should be identified and linked to outlying community hospitals via stroke networks. The National Stroke Association has developed guidelines for the identification of comprehensive stroke centers. However, transfer of acute stroke patients to a regional stroke center would preclude treatment in many patients. Even when 911 is called, the mean time to emergency department (ED) arrival for acute stroke patients is 2.6 hours (4-6). If

the system is accessed through the family doctor or by family transport to the ED, the mean arrival time exceeds 5 hours. Hence, therapy is precluded in many stroke patients simply because of late arrival at the hospital.

To address these concerns, minimal qualifications must be established for physicians and hospitals treating patients with acute stroke. The recommended target for intravenous t-PA in acute ischemic stroke is a door-to-drug time of less than 60 minutes, which is close to the average time for starting thrombolysis after AMI (7,8). To achieve this ambitious goal, hospitals should develop an **acute stroke plan** designed to reduce management delays to a minimum. The National Stroke Association's Emergency Response System Organization at Sites (ERSOS) guidelines provide a detailed template for implementing a comprehensive acute stroke hospital care delivery system (9). Using templates, hospital stroke plans can be tailored to fit local needs but should include four basic elements outlined in the following sections.

Resource Utilization

As the hospital entry point for both ambulance patients and walk-ins, the ED is the common denominator for most acute stroke patients. On-site and en route communication with emergency medical services (EMS) by telemetry, radio, or telephone permits mobilization of the stroke team preferably through a dedicated beeper. An accurate prehospital diagnosis of stroke by EMS personnel using a simplified stroke scale is feasible although less precise than a diagnosis of AMI since there is no simple test like the electrocardiogram for confirmation (10,11).

Preprinted ED stroke order sheets and prepackaged specimen tubes ensure that all necessary chemistries and tests are done before treatment is started. Coagulation studies are essential. The ED should be able to test the activated clotting time (ACT), activated partial thromboplastin time (APTT), and international normalization ratio (INR) on-site and have STAT laboratory access. A 12-lead electrocardiogram machine and electrocardiogram technician should be immediately available. Training the ED nursing staff to perform a 12-lead electrocardiogram and establishing a critical pathway protocol that includes an electrocardiogram as part of the initial evaluation of vital signs in patients with possible stroke will minimize diagnostic delays.

The essential imaging technology for acute stroke is CT. Although more than 90% of hospitals with at least 200 beds have CT scanners (12), personnel and transportation delays consume 1 hour or more between ED and CT in most hospitals. Some hospitals with active stroke programs have a CT scanner in the ED. CT results should be available to the treating physician within 45 minutes of patient arrival at the ED. This can only be accomplished if there is effective integration between the ED, radiology services, and patient transport.

Diagnostic emergency cerebral angiography is required in selected stroke patients and should be available within 60 minutes of presentation to the ED. Neurointerventional procedures such as aneurysm coiling, angioplasty, and intraarterial thrombolysis require special expertise and imaging technology and should be performed at regional comprehensive stroke centers. Intraoperative angiography, stereotactic devices, and microneurosurgical equipment are necessary at comprehensive centers performing complex aneurysm and vascular malformation surgery.

A number of diagnostic technologies are available at comprehensive stroke centers but, although desirable, are not mandatory for all patients with acute stroke. These technologies include emergency carotid ultrasound and transcranial Doppler, magnetic resonance imaging (MRI, MR angiography, diffusion and perfusion MRI, echoplanar MRI), single photon emission computer tomography, positron emission tomography, and transesophageal echocardiography.

After the physician has written an order for a thrombolytic drug to be administered, the agent must be obtained, properly reconstituted, and administered. Stocking the thrombolytic drug in the ED instead of in a central pharmacy significantly decreases the delay to therapy. Use of a thrombolytic drug cart, kit, or tackle box to stock the drug, checklists, standing orders, flow sheets, and adjunctive equipment including intravenous tubing, needles, blood tubes, and tape is one of the most efficient ways to organize the ED team.

A number of novel concepts have recently been developed to focus the attention and efforts of hospital ED staff on treating patients with chest pain in an expedited fashion. The most popular of these ideas is the chest pain center. Most hospitals that have developed chest pain centers have dedicated one or more monitored beds in the ED to the rapid evaluation and treatment of patients with suspected AMI. Some hospitals have dedicated a section of the ED as a clinical decision unit, where patients can be observed for up to 24 hours. This approach can reduce the cost of ruling out an AMI by up to 80% by not admitting all patients to the coronary care unit. A similar approach could potentially reduce acute stroke admissions and costs.

Hospitals lacking **any** intensive care capabilities should not manage patients with acute stroke. Hemorrhagic stroke often requires management in an intensive care unit (ICU) with neurosurgical input. High-risk therapies like thrombolysis and complications such as cerebral edema also necessitate that many ischemic stroke patients have access to intensive care. The utility of stroke units has been demonstrated through shortened length of stay and lower mortality, but not consistently by a better neurological outcome (13,14). However, dedicated stroke units, or even neurological intensive care units, may not be cost-effective in all hospital settings. Hospitals can adapt medical or surgical intensive care beds for acute stroke. Also, many acute stroke patients require only intermediate level neurological monitoring that can be accomplished in stepped units with lower staffing levels than an ICU (e.g., nurse:patient ratio of 1:4 versus 1:2).

Stroke Expertise

New approaches and attitudes toward stroke will require neurological retraining beginning with residency programs. Physicians treating acute stroke must have some neurological experience and must learn the selection criteria for thrombolysis, including the NIH Stroke Scale (NIHSS) (15). The ability to read CT scans, recognize the early signs of brain ischemia, and distinguish hemorrhagic from nonhemorrhagic stroke is essential. Minimum stroke training and continuing medical education (CME) requirements for neurologists, neurosurgeons, family practitioners, internists, emergency medicine physicians, and radiologists must be established by the appropriate national organizations.

A comprehensive stroke team incorporates 24-hour access to a neurologist, neurosurgeon, and interventional neuroradiologist capable of diagnosing and managing any cerebrovascular problem. Subarachnoid and intracerebral hemorrhage require neurosurgical expertise. In outlying hospitals, access to neurological and neurosurgical expertise may require networked telecommunication and transportation links.

In the majority of cases of AMI, the ED physician makes the decision to administer thrombolytic therapy without further consultation. It is typically faster to treat with thrombolytic agents in the ED than to transfer the patient to an ICU. A minority of hospitals require the ED physician to consult with a cardiologist or the patient's primary care physician before administering a thrombolytic drug. Consultation remains essential in patients with relative contraindications or in whom the diagnosis is unclear, but in the majority of cases of AMI consultation only delays the administration of thrombolytic therapy. An analogous situation could pertain to the treatment of acute ischemic stroke, but first there must be improved neurological training for nurses, ED physicians, internists, and family practitioners as well as some standardization of stroke diagnostic and treatment protocols.

Experienced ED physicians can interpret electrocardiograms of patients with chest pain with nearly the same level of accuracy as cardiologists; however, cardiologists are more likely to be correct in the evaluation of difficult electrocardiograms (16). By contrast, many ED physicians receive no formal training in brain CT interpretation. Early signs of infarction on CT have been linked to an increased risk of hemorrhage complicating thrombolysis but are easily missed even by experienced radiologists (17). CT misdiagnosis is an infrequent problem in full-service hospitals with 24-hour access to radiologists, but could be a major problem in outlying community hospitals.

Transmission of an electrocardiogram to a cardiologist by a facsimile machine can provide backup interpretive assistance for the ED physician in difficult cases without significantly delaying care. Teleradiology links could provide similar services for interpreting CT scans in the ED. However, unlike the electrocardiogram in AMI, CT is normal in most patients with early ischemic stroke and the diag-

nosis ultimately rests on clinical neurological expertise. ED physicians, internists, and family practitioners must therefore receive sufficient neurological training during residency and through CME to be able to diagnose and treat acute stroke.

Guidelines, Algorithms, and Critical Pathways

Identification and prioritization of patients with AMI or acute stroke are challenges in every busy ED. Only 4-5% of patients with chest pain who present to the ED are candidates for thrombolytic therapy (18,19). Similarly, recent stroke thrombolysis trials suggest that fewer than 5% of screened patients are eligible for therapy (15). Therefore, triage nurses may have to screen 25 patients to find one stroke patient who is eligible for urgent treatment. This low yield greatly reduces the incentive for nursing and medical staff to immediately evaluate every patient who arrives at the ED with suspected stroke symptoms. Ambulatory patients pose a particular problem, since their presentation to the ED may not be as dramatic as that of patients who arrive by ambulance. If registration is required for ambulatory patients prior to seeing a triage nurse, there is a further delay, particularly when the ED is busy and overcrowded.

Guidelines, algorithms, and critical pathways are important tools for minimizing delays and enhancing the triage of patients with acute stroke. Guidelines for the treatment of acute ischemic stroke have been published and recently were supplemented for thrombolysis (20,21). Similar guidelines have been published for subarachnoid and intracerebral hemorrhage (22,23). The thrombolysis guidelines set a promising new trend since they were jointly developed by the American Heart Association Stroke Council and the American Academy of Neurology. Guidelines improve the process of care although by themselves are insufficient to implement changes in physician behavior (24-27).

Critical pathways build on guidelines by identifying the optimal sequencing of medical management decisions and thereby enhance efficiency in the process of care (28). Integrated critical pathways have both area-specific (ED, angiography suite, ICU, regular nursing floor) and diagnosis-specific (ischemic stroke, subarachnoid hemorrhage, intracerebral hemorrhage) components. Critical pathways are often implemented by nursing personnel as they assure the continuity of care in different locations and by different medical specialists. They are also important tools for quality assurance (29).

Algorithms are tools that physicians use to organize the process of making diagnostic and treatment decisions. Evidence-based algorithms for stroke have been developed but have not been widely adopted (30,31). Algorithms are controversial since they cannot take into account all of the variables and options involved in clinical decision-making and therefore run the risk of creating "cookbook" medicine. Algorithms should not be used as surrogates for neurological expertise but can provide some guidance in clinical decision-making.

Quality Improvement

The ultimate goal of any hospital acute stroke plan is to improve patient outcome. Therefore, quality improvement is an essential component of any hospital acute stroke plan, and is becoming even more important as hospitals and physicians seek to justify health care expenditures.

Community-based attempts to assess quality of care and outcomes in acute stroke have emphasized costs, length of stay, and in-hospital mortality rather than long-term disability or handicap. Available models rely heavily on coma and level of consciousness (LOC) to predict risk of death from stroke. Coma and LOC on admission are very important in predicting mortality after intracerebral hemorrhage and subarachnoid hemorrhage (32,33), but LOC alone is insufficient to predict mortality after brain infarction (34-36) and thrombolysis does not reduce ischemic stroke mortality.

Many stroke outcome models reflect the trend toward creating "minimal clinical data sets" by relying on a few easily extracted physiological variables that show statistical correlation but have no clear relevance to quality of care (37). Skepticism about outcomes research was highlighted by Iezzoni et al (38) who compared 11 different severity-adjusted models assessing stroke mortality and found that 25% of the hospitals were ranked differently, either "better" or "worse," depending on which particular model was used.

Previously there has been little pressure on physicians or hospitals to systematically change the way they examine stroke patients or record essential data (39). The omission by statistical models of stroke outcome variables validated in peer-reviewed medical literature reflects the fact that such data are not routinely collected by physicians and recorded in the medical record in a standardized format. Furthermore, measures of treatment efficacy used in clinical trials, such as stroke scales (NIHSS) and functional measures of stroke outcome at 90 days (Barthel index or modified Rankin scale), have not been the standard of care in the community setting.

It is doubtful whether short-term stroke mortality can be used to meaningfully compare quality of care between hospitals. Most of the variation in mortality between hospitals reflects not quality of care but systematic differences in unmeasured or unobserved patient characteristics, inadequacy of the fit of the model, and random error (40). Short-term mortality models cannot normalize for all of the known and unknown variables affecting outcome in different patient populations regardless of how much clinical information is available. Alternatives include process analysis, which could be linked with critical pathways, functional assessment, and patient satisfaction.

Attempts to work with neurological specialty societies to develop algorithms for stroke care have met with limited success (41). Problems included imprecise data collection and coding, and consensus difficulties due to lack of agreement over

appropriate practice criteria. As expensive and dangerous new therapies like thrombolysis emerge, research on community-based stroke outcomes is urgently needed (42). A clinically relevant national stroke database created with community physician compliance in mind would greatly facilitate this effort.

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Critical Pathways

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Effective care of cerebrovascular disease requires a team of efficient, informed colleagues who can work together in carefully planned patterns appropriate to the problems posed by individual patients. Care pathways are essential tools in the evaluation and therapy processes. Every stroke care center has the responsibility to match its resources with generally agreed upon guidelines for each of the clinical presentations of cerebrovascular disease and to show that its patterns of care are effective and efficient.

Components of a Care Pathway for Stroke

The early components of the pathway should be designed to protect the brain until the pathogenesis of injury is defined, and then to apply therapy appropriate to the pathogenesis and severity of the injury. At present, one of the greatest values of pathway-guided care is speed. The most powerful therapies for ischemic stroke are most effective only within the first few hours of the ischemia, and careful planning is necessary if the evaluation is to be completed in time. Pathways should plan care beyond initial decisions and management, making most effective use of resources and allowing care to be tailored to the needs of the individual patient.

A. Initial Management

Initial management begins when emergency medical services personnel first begin transporting the patient to the hospital and continues into the emergency department (ED).

1. Prehospital care:
    - How does the emergency transport service inform the stroke center?
    - How and when do stroke center physicians learn of the problem?
    - How is communication managed with transporting services?

2. Hospital ED care:
   - Who is responsible for initial patient evaluation and treatment decisions?
   - What initial support should be provided?
     - Oxygenation
     - Blood pressure management
     - Cardiac evaluation
   - What are the initial aids to diagnosis and management?
     - Blood tests
     - Electrocardiogram
     - Pulse oximetry
     - Cranial imaging with CT scan

B. Early Management of Acute Stroke in the ED and for Hospitalized Patients

1. Ischemic disease
   - Consideration of thrombolysis
   - Consideration of anticoagulation
2. Primary intracerebral hemorrhage
   - Consideration of operative intervention
     - Ventricular shunt
     - Hematoma evacuation
   - Consideration of early angiography
3. Subarachnoid hemorrhage
   - Consideration of angiography
   - Consideration of early operation

C. Planned Management of Care After Acute Treatment

1. Level-of-care decisions, particularly intensive and intermediate care requirements
2. Selection of any further diagnostic evaluations
3. Initiation of rehabilitative therapy
4. Development of alternatives for care after discharge from the hospital

D. Posthospitalization Planning and Followup

1. Anticoagulation supervision
2. Communication with primary care providers
3. Measures for secondary prevention of stroke and cardiac disease
4. Outcome measures

Planning the Pathway

In general, the pathway is based on the best evidence for effective therapy, the severity of the deficit for a particular patient, and the resources available for care. It is essential that pathways respect the limitations of the institution and setting. For example, a regional stroke center must have pathways for surgical intervention when managing patients

with subarachnoid hemorrhage, while a brain attack center should have plans in place for transport of patients with subarachnoid hemorrhage to a regional stroke center. A hospital that cannot provide timely expertise or cranial imaging should plan for rapid transfer after initial evaluation and institution of supportive therapy.

All members of the brain attack team should be involved in planning the pathway.

Team Components

- Neurological medical expertise
- Neurological surgery expertise
- Emergency medical expertise
- Critical care medical expertise
- Imaging (acquisition and interpretation)
- Laboratory support
- Nursing (emergency, intensive, and standard)
- Pharmacy
- Hospital communication
- Emergency medical services
- Hospital administration
- Social services
- Rehabilitation medicine

For each institution, the pathway should represent a synthesis of consensus guidelines and the resources of the institution. Whenever possible, planning should take advantage of the efforts of national organizations to provide reasonable guidelines for care. These include:

American Heart Association

1. Guidelines for management of patients with acute ischemic stroke
2. Guidelines for thrombolytic therapy for acute stroke
3. Guidelines for management of aneurysmal subarachnoid hemorrhage

National Stroke Association

1. Stroke center recommendations

Monitoring and Improving the Pathway

All members of the team must take advantage of every opportunity to improve the design of the pathways, to assure that every patient has the benefit of the pathway, and to assess the efficacy and efficiency of the pathway. To accomplish these goals the brain attack team must monitor its own activities and learn the outcome of patients served by the pathway. The costs of the tests and therapies should be known and should be individually defensible.

In general, the brain attack team should systematically acquire information about its patients, the interventions, and the outcome. Databases are now being designed by the American Academy of Neurology that will facilitate local evaluation and comparison with data from other institutions.

Acute Hospital Care: Resource Utilization

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What constitutes the minimal and maximal resources needed for acute stroke care? How should "primary" and "comprehensive" stroke centers be defined, and is there something in between?

To help hospitals begin to develop stroke plans appropriate for local needs, we have subdivided stroke resource components into **nursing, diagnostic, stroke team,** and **therapy.**

A **primary stroke center** would have the following minimal facilities needed to carry out medical acute stroke therapy, including intravenous thrombolysis:

Nursing: a receiving area with the ability to monitor vital signs and cardiac function, suction, give intravenous hydration, and initiate intubation and ventilation.

Diagnostic: CT completed within 25 minutes and read within 45 minutes (might employ teleradiology), electrocardiogram, and laboratory for basic hematology, chemistry, and coagulation tests.

Stroke team: a neurologist or other physician with stroke expertise on call within 15 minutes, either on site or by telemedicine. Neurosurgical availability on site or by transport within 2 hours. Radiologic expertise to interpret CT scan.

Therapy: pharmacy, monitoring capabilities for vital signs, oximetry, and neurological status as per published guidelines. For eligible patients, a door-to-drug time of 60 minutes.

In addition to the above, a **comprehensive stroke center** would have complete facilities and expertise available for all aspects of stroke therapy, diagnosis, and secondary prevention.

Nursing: all of the above with one dedicated nurse for the patient during treatment, a designated space for acute stroke treatment, oximetry, and the ability to assess the patient within 10 minutes of emergency department (ED) arrival.

Diagnostic: all of the above with CT scan completed and read within 30 minutes, magnetic resonance imaging and angiography (MRI/MRA), carotid ultrasound, and transesophageal echocardiography. Cerebral catheter arteriography with endovascular team available to have patient catheterized within 45 minutes of ED arrival. Optional newer techniques such as CT angiography, diffusion and perfusion MRI, single photon emission computed tomography, and transcranial Doppler.

Stroke team: multidisciplinary team available within 15 minutes, 24 hours a day, 7 days a week; should include a neurologist, neurosurgeon, endovascular neuroradiologist, and stroke nurse. Communication system established between stroke team, ED, and prehospital emergency medical services (EMS) for early identification and prioritization of appropriate patients for acute stroke therapies. A backup system established for communication breakdowns. Establishment of critical pathways and standing orders for stroke patients in the ED and after admission. Flow-charting and other techniques for speeding patient triage, diagnosis, and treatment in the ED. Maintenance of a registry of stroke patients, treatment, and diagnosis.

Therapy: pharmacy response within 15 minutes. Critical care or stroke unit beds available with no more than four patients per nurse and 24-hour physician availability. Operating room and staff familiar with cerebral aneurysm and carotid artery surgery.

Rehabilitation facilities: physical, occupational, nutritional, and speech therapy available within 24 hours of patient admission.

Comprehensive stroke centers are typically involved in clinical and basic stroke research. They may have stroke fellowship programs and are active in stroke continuing medical education.

Intermediate stroke centers would incorporate some, but not all, of the features of a comprehensive center and would provide more skilled services than a primary stroke center. For example, emergency cerebral angiography and uncomplicated cerebrovascular surgery may be available, but 24-hour endovascular neuroradiology services, complex cerebrovascular surgery, dedicated stroke intensive care units, or new imaging technologies such as diffusion weighted MRI may not be available.

There are many arguments for and against the concept of stratification of stroke centers. Arguments in favor of some form of stratification include:

1. It would reinforce the concept that stroke treatment in the 21st century requires revised planning and allocation of resources for all health care providers including acute care hospitals.

2. It would provide an impetus for centers interested in stroke care to organize themselves and select the level of care appropriate to their particular site.

3. It would enable health care networks to optimize resource utilization and standardize care across the network.

4. It would help EMS professionals and referring physicians identify where stroke patients should go to receive optimal care.

5. It would foster outcomes assessment and quality improvement.

Arguments against stratification include:

1. A system of "haves" and "have-nots" would be created which would discourage the "have-nots" from developing a program of care for acute stroke patients, and perhaps discourage future innovation among the "haves."

2. Most stroke patients presently do not qualify for acute stroke therapies because they do not arrive quickly enough at a hospital where the expertise is available. Since available stroke therapies (intravenous t-PA) and those under development (neuroprotective agents) can be given at most hospitals with minimal facilities (i.e., primary stroke centers), establishing a rigidly stratified system might restrict patient access to rapid treatment.

3. Establishing and monitoring a rigidly stratified system would require a complex administrative suprastructure.

4. A rigidly stratified system may have undesirable political, regulatory, and medicolegal consequences.

The goal of any stratification system should be to increase patient access to high-quality stroke care. Hence, all systems should be flexible, voluntary, and based on a hospital's ability to meet key guidelines established through national consensus. There was little support for mandatory certification of stroke centers. The purpose of such stratification would be to include as many hospitals as possible in the care of acute stroke patients at a level commensurate with their resources.

Lastly, the measure of efficacy of any acute stroke center, regardless of care level, should be outcomes based. Time targets can be used to measure system efficiencies, e.g., percentage of patients treated within 60 minutes of arrival. Centers should also be able to compare costs, length of stay, and (most importantly) mortality and morbidity outcomes with those from centers that have similar levels of care and with national benchmarks. Optimal stroke outcome will also require prevention of secondary complications of stroke, optimal specialized nursing care, rehabilitation, and secondary stroke prevention.

Acute Stroke Management: Hospital Stroke Expertise

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Goals for Special Expertise in the Care of the Stroke Patient

The need for expertise in the care of the acute stroke patient is governed by three, well-established goals:

1. To minimize the extent of brain injury.
2. To medically support the stroke patient and encourage optimal chance for functional recovery.
3. To prevent further brain injury secondary to the initial accident or repeated vascular accidents.

The above goals are unlikely to change though the tools available to achieve them are constantly being refined. The wide array of management problems posed by treating patients with acute neurovascular emergencies drives the requirements for medical expertise. The development of new tools that improve patient outcome after stroke necessitates new expertise to ensure patient access to optimal care. The following discussion is centered primarily on skills and knowledge needed by hospital medical professionals involved in the emergency management of the acute ischemic and hemorrhagic stroke patient.

Advanced Stroke Expertise in Current Practice: Goals for Emergency Management of the Stroke Patient

Certain guidelines for emergency care, based on clinical experience and knowledge of pathophysiology, have been accepted in many institutions as the standard. These guidelines have led to the development of varying levels of coordinated care between emergency physicians, neurologists, neurosurgeons, general practice physicians, and radiologists. Only a few guidelines have been studied in randomized clinical trials and some, though not all (1-3), are labeled controversial.

Generally accepted standards for management are frequent in treating patients with stroke, especially hemorrhagic stroke, which requires prompt diagnosis and neurosurgical intervention to preserve life and brain function. Because it is not possible to reliably distinguish among different stroke types in the field, and because intracranial hemorrhage is a complication of many treatments, comprehensive stroke centers require access to the expertise needed to manage all forms of stroke.

Currently, centers without the expertise to manage some of these intracranial emergencies develop referral patterns with other institutions that have special resources. All stroke care programs require staff with the expertise to recognize the different stroke types and to manage their acute presentations.

Present and Future Needs for Expertise in Stroke Care

Given the tragic personal loss and financial cost of long-term care of the stroke patient, changes in medical expertise will be dictated by new therapies that improve the patient's functional outcome. Stroke research has clearly established that a variety of strategies decrease infarct size in animal stroke models (4).

A number of agents are currently in clinical trials; one of these agents, t-PA, has recently been approved by the FDA for the treatment of stroke. This approval was based on results from clinical trials performed by organized stroke teams. Results in community practice may differ. This is especially of concern for agents whose benefit relies on strict conditions of use and sophisticated stroke experience. Duplication of the expertise required by the clinical trial stroke teams at the community level is the most defensible position in planning to incorporate a new stroke therapy.

The major current challenge is to meet the increased need for acute stroke expertise and to make stroke expertise as available as possible in sparsely populated settings. Communications technology should make it possible to share resources over geographic areas. Telecommunications to transmit high-quality brain images to expert stroke physicians and video conferencing to bring neurological expertise into the emergency department (ED) and inpatient units should allow the development of acute stroke teams with members in widely separate locations. Larger health care corporations may test the benefit of using telecommunications to centralize their acute stroke care decisions. A relatively small team of specialists may communicate with a large network of emergency facilities.

Identifying Appropriate Patients for the Administration of t-PA in Clinical Practice

One major difference between the evolution of treatment of ischemic brain attack and the evolution of treatment of ischemic myocardial attack is the lack of a reliable diagnostic test for stroke in the emergency setting. Intravenous thrombolysis in myocardial infarction is predicated on combining an appropriate clinical evaluation with a positive diagnostic test—ST segment elevation on the electrocardiogram. Intra-

venous thrombolysis in stroke is predicated on appropriate clinical evaluation and a negative test—the absence of abnormality on the CT scan. At present, the clinical neurological evaluation is the sole procedure upon which to make decisions about the use of a fairly toxic drug. Sensitive and specific diagnostic tests to identify cerebral ischemia or an occluded cerebral artery in the acute setting are currently under investigation (5).

Excluding Inappropriate Patients for the Administration of t-PA in Clinical Practice

The risk of intracranial hemorrhage with the use of intravenous t-PA places a premium on not treating patients unlikely to benefit. Even in established centers, up to 19% of patients are incorrectly diagnosed as suffering from acute stroke (6). In the NINDS t-PA Stroke Study (7), t-PA was administered by teams of neurologists and emergency physicians with expertise in stroke and in CT interpretation. One of many differences between the successful NINDS study and the failed European Cooperative Acute Stroke Study (ECASS) of t-PA (8) was the high rate of intracranial hemorrhage and mortality in patients entered into the ECASS study who did not meet specified entry criteria.

Expertise is needed to exclude patients in whom t-PA treatment is dangerous or not appropriate including:

1. Patients with CT signs of hemorrhagic stroke: subarachnoid hemorrhage, intracerebral hemorrhage, subdural or epidural hemorrhage.
2. Patients without stroke who may present with a history suggestive of stroke-like onset of focal neurological deficit.
3. Patients with rapidly resolving neurological deficits.
4. Patients in whom the time of onset is difficult to establish (especially difficult in patients with stepwise progression of deficits in which the last of multiple events brought them to the hospital).
5. Patients in whom the CT scan shows infarction.

Estimating Risk and Benefit

Stroke expertise is also necessary to discuss the risks and benefits with the individual patients. In community practice the decision to treat with t-PA is determined by: (a) the individual's risk of t-PA-induced hemorrhage and death; (b) t-PA's expected effect on the individual's potential for neurological recovery; and (c) the individual's (surrogate's) wishes to accept (a) in an attempt to attain (b). This discussion must occur but can be difficult and requires considerable stroke knowledge. The patient and family are usually most influenced by the physician's prediction of the expected long-term outcome without intervention. Some knowledge of the patterns of stroke recovery is necessary to present the risks and benefits of t-PA in the ED.

Management of Treated Patients

The NINDS t-PA Stroke Study and the American Heart Association recommendations for t-PA include strict monitoring and regulation of blood pressure below defined upper limits with antihypertensive agents (2). They mandate hourly assessment of neurological status for 24 hours after treatment. They include protocols for emergency management of hemorrhage in t-PA-treated patients, specific guidelines for the control of hypertension, and recommendations for management of bleeding complications. The American Heart Association recommends admission of treated patients to a skilled care facility (intensive care or acute stroke unit). This underlines the need for inpatient stroke care expertise on the part of nurses and physicians in facilities using t-PA for acute stroke patients in the ED.

Treatment of Intracranial Hemorrhage

The risk of hemorrhage after t-PA necessitates careful monitoring of treated patients to prevent, as well as to detect and respond to, intracranial hemorrhage should it occur. Patients with intracranial hemorrhage require specific medical, neuroradiological, and neurosurgical response. Expertise to deliver such a response must be available for patients treated with t-PA as it is for other patients with intracranial hemorrhage. The American Heart Association recommends that thrombolytic therapy not be used unless facilities that can handle bleeding complications are readily available.

Expertise in the treatment of patients with intracranial hemorrhage currently includes:

(a) Neurosurgical response to evacuate hematoma when appropriate.

(b) Intensive care management of changing neurological function to:

  (i) guide timing of (a);

  (ii) administer cryoprecipitate and platelets; and

  (iii) manage raised intracranial pressure.

(c) Neuroimaging expertise to emergently detect intracranial hemorrhage and mass effect.

Management of the Acute Stroke Patient After t-PA Treatment

Expertise in the management of the stroke patient in the days following t-PA use is crucial to allow the patient to recover to his or her full potential. Diagnostic and therapeutic decisions will have an impact on the patient's risk of recurrent stroke. These issues are not dealt with here.

The Stroke Team, t-PA, and the Future of Acute Stroke Care

The above discussion centers on the medical decisions that a hospital staff faces in attempting to provide optimal care for the stroke patient. Noncontroversial requirements exist for: (a) emergency clinical evaluation of the stroke patient by knowledgeable staff; (b) accurate, emergency evaluation of the CT scan; (c) knowledgeable discussion with the patient and family

of available acute treatments, risks, and benefits; and (d) availability of stroke-trained nurses and physicians to ensure safe inpatient management. At present there are too few stroke physicians (primarily specialized neurologists numbering only a few hundred) who engage in all phases of acute and inpatient management. A stroke team of dedicated professionals with a variety of training backgrounds is needed to meet the requirements set by the 500,000 strokes that occur annually in the United States.

The introduction of t-PA as an FDA-approved treatment for certain stroke patients within 3 hours of symptom onset calls for improved organizational efforts to manage these patients. It does not necessitate anything unique, but it does mandate that the same level of organization and expertise currently applied to myocardial infarction, head trauma, and intracranial hemorrhage be available to patients with ischemic stroke. Perhaps the greatest challenge is to provide consistent, 24-hour-a-day stroke care. The current level of stroke expertise can not meet the need for universally available acute stroke treatment. Professional stroke education programs are needed to recruit emergency physicians, neurologists, radiologists, emergency nurses, intensive care physicians and nurses, and primary care physicians to form stroke teams. Hospitals must form networks to ensure that patients with all types of neurovascular emergencies have access to needed expertise, especially stroke and neurosurgical expertise.

The Future

Major improvement in tissue preservation requires timely reperfusion. Future stroke care will strive to reduce the risks and improve the benefits inherent in thrombolysis. Hyperacute administration of cytoprotective agents will likely show benefit and require the level of coordinated effort demanded by t-PA. Agents that limit reperfusion injury may improve the risk/benefit ratio of thrombolysis. These new agents and combinations of multiple therapies will improve patient outcome but complicate medical decision-making. An expansion of stroke expertise will be necessary to ensure access to optimal stroke treatments and to evaluate and optimize their performance in community use. Expanded medical expertise and coordinated systems of stroke care will also enhance the development of new and better strategies to diagnose and treat stroke. The rapid institution of stroke teams will advance the present level of medical expertise and lead more quickly to better stroke care for the nation.

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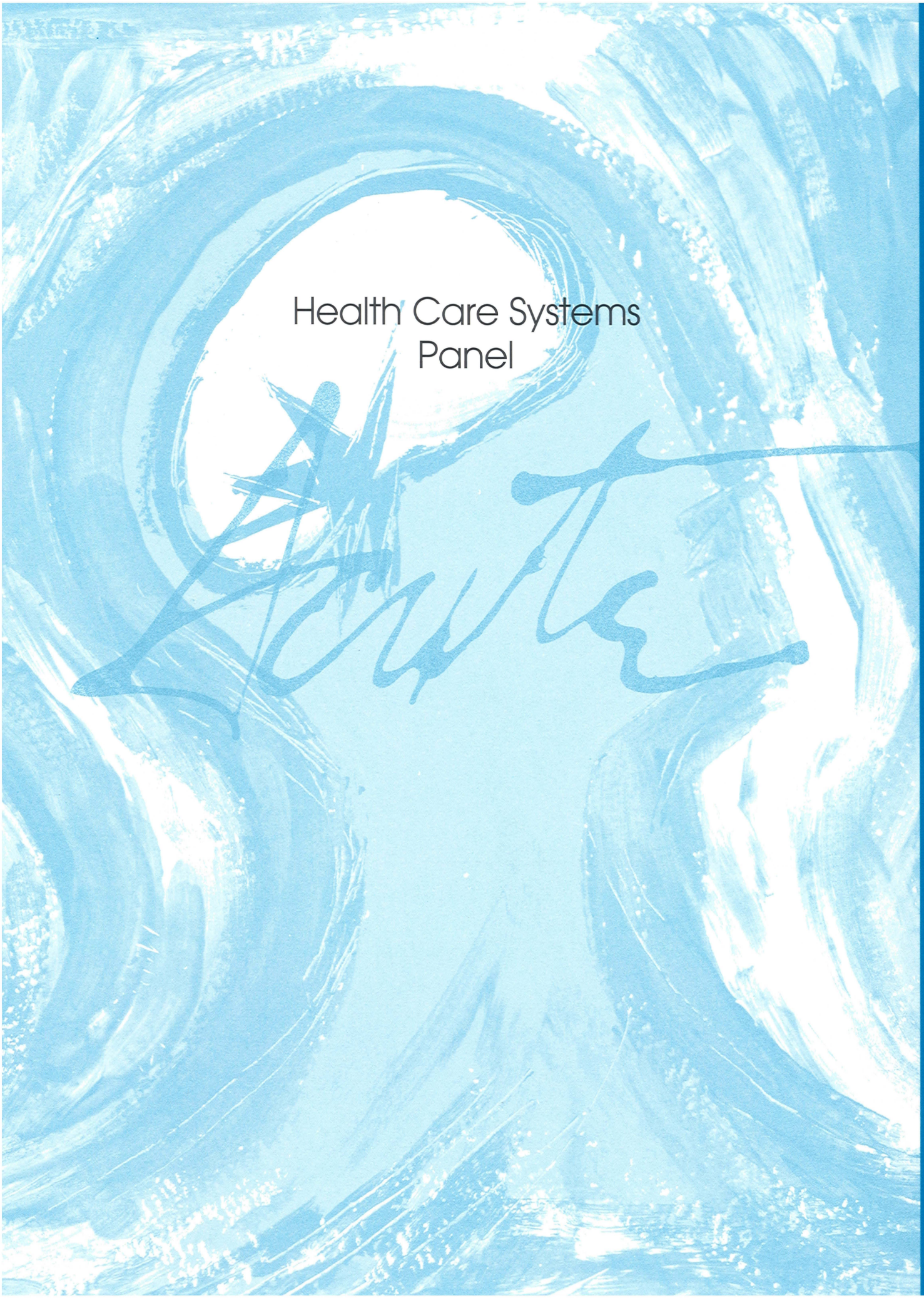
Table 1.
Stroke teams in standard care of patient groups in whom specific emergency intervention has shown benefit.

Patient Group	Emergency Expertise	Neuroimaging Expertise	Neurosurgical Expertise	Inpatient Unit Expertise
Intracranial hemorrhage: • subarachnoid • intracerebral • subdural • epidural • lobar	Emergency staff trained to recognize signs of stroke and rapidly stabilize hematologic and cardiopulmonary status. Emergency transport services to transfer patients when necessary to sites with needed expertise.	Emergency CT scan to identify or rule out hemorrhage or mass effect. Emergency availability of cerebral angiography to identify aneurysm, AVM, or venous sinus thrombosis. Neurointerventional team for endovascular occlusion of inoperable vascular lesions; intra-arterial papaverine or angioplasty for vasospasm after SAH.	Emergency neurosurgical response to evacuate hematoma, clip berry aneurysm.	Trained intensive care staff (nurses and physicians) to manage hemodynamic parameters and intracranial pressure, treat vasospasm, and monitor neurologic status in the pre- and post-operative period. Stroke neurology staff to manage venous thrombosis and aid neurosurgeon in the management of others.
Cerebellar infarction	Recognition of signs of cerebellar infarct; often requires stroke neurology staff.	Define vascular lesion using angiography, CT or MR angiogram, or transcranial Doppler. Emergency imaging to detect secondary hydrocephalus or brainstem compression.	Emergency neurosurgical response to decompress posterior fossa or place ventriculostomy.	Trained staff to recognize signs of hydrocephalus or brainstem compression. Stroke neurology staff to manage patients with likely underlying vertebrobasilar artery stenosis or occlusion, and to monitor anticoagulation.
Basilar occlusion	Recognition of signs of basilar disease. Often requires input from stroke neurology staff.	Define vascular lesion as above; neurointerventional team for intra-arterial thrombolysis.	Emergency neurosurgical response to evacuate potential posterior fossa hemorrhage.	Stroke neurology and trained staff to monitor cardiopulmonary condition, anticoagulation, and neurologic signs. Intensive care unit for management after thrombolysis.

Table 2.
Task-specific guidelines for medical expertise in the treatment of acute stroke with t-PA.

	Goals	Training	Location	Professionals to Train for These Roles
		Pre-Treatment Expertise		
Clinical Evaluation	a. Identify appropriate stroke patients b. Exclude patients from t-PA treatment who do not have ischemic stroke or have little chance of benefit	a. Experience in recognizing and dating symptoms and signs of acute stroke types; knowledge of management of acute stroke types b. Experience in diagnosis of conditions that mimic ischemic stroke c. Knowledgeable in use of t-PA	Available in the ED; special personnel on site, in phone contact with emergency staff, in phone contact with family, in video contact, on call to ED	a. EMT b. Triage nurse c. ED nurse d. ED physician e. Neurologist f. Primary care physician
Radiologic Evaluation	a. Identify intracranial hemorrhage b. Identify signs of early stroke, or recent stroke	Experience in recognizing subtle SAH, subdural and epidural hematoma, AVM, tumor, cavernous angioma	Available to ED; personnel on site or quality appropriate images downloaded for interpretation	a. Neuroradiologist b. Neurologist c. General radiologist d. ED physician
Informed Consent	a. Discuss likely long-term disability from stroke b. Discuss risks of hemorrhage and death from stroke and from t-PA use c. Discuss potential for individual to benefit from t-PA	Knowledge of outcome after stroke, risks/benefits of t-PA	Personnel on site or in phone contact with patient and family	a. Neurologist b. ED physician c. Primary care physician
		Immediate Post-Treatment Expertise		
Medical Management	a. Monitor neurologic function for signs of hemorrhage, brain edema, progressive stroke b. Monitor and control blood pressure c. Identify and treat hemorrhagic complications d. Manage raised intracranial pressure in case of hemorrhage or malignant ischemic edema	Nursing and physician experience in critical care of neurology/neurosurgery patients	a. Intensive care unit or specialized stroke unit b. Unit on site or at site to which patient can be rapidly transferred	a. Neuroscience nurses b. Intensive care nurses c. Intensivists d. Neurologists with training in stroke/intensive care
Surgical Management	a. Evacuate and manage intracranial hemorrhage b. Perform carotid endarterectomy when appropriate	Experience in managing patients with subdural, epidural, and intracranial hemorrhage	On call to site, or on call to site to which patient can be rapidly transferred	Neurosurgeon
Radiologic Management	Emergency ability to recognize intracranial hemorrhage and mass effect due to cerebral edema	Experience in brain CT evaluation (changes are usually dramatic)	On site or images downloaded for interpretation and physician in phone contact	a. Radiologist b. Neurologist c. Primary care physician
Quality Assurance	a. Collect data on patient outcome and complications b. Improve time to treat appropriate patients c. Identify patients treated inappropriately and change practice accordingly d. Refine practice and incorporate resources needed to provide safe, effective stroke care in the community e. Incorporate new treatments into the acute stroke armamentarium	Experience in data collection and quality assurance	On site or part of larger database	Stroke team leader and support personnel

Health Care Systems Panel



Overview: Health Care Systems

A Must for Integrated Disease Management: A Focus on Acute Stroke Care

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Introduction

We are in the midst of the most significant decade of change for health care delivery in America. Government, business, and, most importantly, our patients and their families are speaking out to tell us that the care we provide is often not acceptable and many times not affordable. These voices are demanding a transformation in the delivery of health care, with managed care accepted as a style of practice rather than a payment mechanism.

This transformation in the health care system provides the infrastructure for the rapid identification and treatment of acute stroke since it emphasizes delivering care in a continuum rather than in fragmented episodes, and it is focused on primary intervention rather than inpatient procedures only. To make this transformation successful, it will be helpful for health care providers to see themselves as part of a three-dimensional delivery model.

The Three Dimensions of An Integrated Health Care Delivery System

Envisioning a three-dimensional model can help to conceptualize how the different components of a health care system must be integrated and set in motion to achieve the highest quality of care at the lowest cost for any disease process. These components can be connected formally, as in a largely owned urban health care system, or informally by strategically aligning all the delivery parts serving one geographic population.

The **first dimension** is "growing" all the parts necessary to provide the continuum of care for the disease process. The **second dimension** is connecting all the parts to form a seamless delivery system. The goal of this step is to ensure that patients not only have access to all components of the system, but can also receive maximum benefit at each treatment location. The **third dimension** requires the creation of clinical process improvements for disease management horizontally through all the treatment locations to assure that the outcome will create the greatest value for the

patient—the highest quality of care at the most affordable cost.

The Treatment of Stroke: Connection to the Three Dimensions

Each of the other four sections in this monograph—Prehospital Emergency Medical Care Systems, Emergency Department, Acute Hospital Care, and Public Education—represents an important part of the first dimension of acute stroke identification and treatment. The second dimension represents the effective and efficient integration of these services. In a given geographic area, a large health system must provide, or smaller components must come together to provide, all of the services needed by a patient having an acute stroke. Through planning and cooperation, this second dimension will allow for the regionalization of locally delivered and centralized services. The third dimension strategically aligns these acute stroke identification and treatment services so that the patient can move efficiently and rapidly from one point to the other. All care providers operating in these delivery systems must develop and implement the best practices, established guidelines, and expectations for each service required in the acute stroke continuum. Initiatives for improving acute stroke clinical processes—the third dimension—should focus on reducing unintended variations and support ongoing improvements and innovations. These initiatives will help us improve our daily work.

Questions We Must Ask

Regardless of the part of the health care delivery system we represent, all of us seek the knowledge needed to improve acute stroke identification and treatment in our communities. Our tasks can perhaps be summarized best in the following questions:

1. What delivery system are we a part of formally or informally?
2. Are we prepared to strategically align the necessary service parts to rapidly identify and treat patients with acute stroke?
3. Are we willing to adopt the guidelines necessary to create a clinical process across all the service parts to reduce unintended variations and increase ongoing improvements?
4. Are we willing to identify and remove barriers to foster a more rapid cycle time for the processes described in this monograph?

The Ultimate Purpose of the Effort

We are all connected to health care because we want the best outcomes for our patients and their loved ones. As we learn about new treatment processes, we must not only implement them, but we also must measure our performance across the system using standardized techniques. These measurements should include clinical quality, functional status, patient satisfaction, and cost. Establishing a system fosters internal and external benchmarking of the best practices to promote ongoing improvement and innovation. The rapid identification and treatment of acute stroke demands a focus on this purpose.

Summary

The best practices to rapidly identify and treat acute stroke victims are outlined in the reports presented in this monograph. To implement these practices, all parts of the delivery system must come together in a coordinated and three-dimensionally integrated fashion. The often disjointed collection of tangentially related service points of the past cannot be tolerated in the future. Working together as part of a larger health care delivery system, we can deliver the most efficient and effective acute stroke care.

Developing Leadership and Systems Analysis

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An integrated health care system has the ability to provide for the care of the patient across the entirety of a disease process, including prevention, acute care, chronic care, and secondary prevention. Integration allows investment in one area to produce benefits in other areas. An increase in initial hospital costs due to acute treatment can be recouped by decreased rehabilitation or nursing home costs. Patients must be able to access the appropriate subunits of the system in the appropriate time-frame in order to receive proper care. For the patient with an acute stroke these components include prehospital care, emergency care, hospital care, and rehabilitation. Further, patients must receive guidance from the primary physician (or other patient educator) so that they and their families know when and how to access care. Patients also expect that their care will be arranged in an efficient and seamless manner.

Patients who are not part of an integrated health care system can still expect the same quality of care if the subunits are brought together by medical leadership and if care paths are developed for the rapid identification and treatment of acute stroke.

Identifying leaders to act as "champions" for acute stroke patients may not be an easy task. These people need sufficient conviction, commitment, and energy to overcome the inertia of current practice. Hospital and prehospital leadership (emergency medical services [EMS] directors, chiefs of staff, chairmen, medical directors, and nursing directors) should assist in identifying those who would best fit the role of champion in their institution. Conviction and commitment will often come from a thorough understanding of the current concepts of acute stroke treatment and the desire to help patients who until recently had no opportunity to receive acute care.

Champions must be able to effectively communicate the goals of acute stroke care to all involved. At least one person should be identified from the prehospital system (EMS), the emergency department, the hospital staff of stroke experts, and the department of nursing to form a core group or team. These individuals must work together to develop systems to manage stroke patients efficiently across the various phases of care.

The first task of the team should be to analyze their current system of acute stroke care, identifying the resources needed to care for patients in the desired manner. Analyzing the three phases of care from the patients' point of view helps to create a system that is efficient. In addition, the systems should be analyzed from the inside out, that is, starting with the hospital phase, proceeding to the emergency phase, and finally moving outward to the prehospital phase. Understanding the patients' and caregivers' needs in the subsequent phase of care allows for anticipation and facilitation of these needs. For example, it is important for emergency department staff to understand how and when to access intensive care for patients with stroke. Likewise, if EMS can transport a family member or a witness with the patient, it allows for more accurate and rapid determination of the time of onset of stroke symptoms. This will create a greater understanding of the needs of each component, and opportunities to meet the needs of the ensuing phase will not be missed.

At some participating centers in the NINDS t-PA Stroke Study (1), the method of system analysis used flow-charting to gain a clear and detailed understanding of the processes involved (1). This understanding helped identify delays to treatment as well as opportunities for improved efficiency.

Flow-charting uses a series of symbols connected by arrows, which point in the direction of progress, to describe a process. Ovals are used at the beginning and end of the process, diamonds are used for decision points, and rectangles are used for actions. Written descriptions of the particular event are placed inside the figures. This method allows for highly detailed analysis (Figure 1A and 1B). Furthermore, it identifies key personnel who participate in the processes (such as nurses, unit clerks, laboratory technicians, CT technicians, dispatchers, pharmacists, EMS personnel, and various physicians) or who may be added to the team to assist in process modification, educational efforts, and subsequent stroke patient care. Therefore, process problems are identified and modified by involving those who carry out the process before any patients are ever treated.

Processes in the system should be simple and easy to use, and should not unduly burden the patient care systems already in place for stroke or other diseases. Furthermore, they should be designed to function under the most difficult situations. Individualized processes must be developed at each location because of the wide variety of medical practices: single hospital sites, multiple hospital sites, teaching hospitals (private and university),

Veterans Administration hospitals, and community hospitals of varying sizes. Acute stroke treatment can be carried out in a wide variety of settings, and it is unlikely that any two systems will be identical.

The definition of the team also varies depending on the human resources available. Usually, stroke teams include a small number of individuals who are available for the evaluation, treatment, and management of every identified stroke patient. This core team will train a large number of prehospital, emergency, and hospital personnel to rapidly identify, screen, and support stroke patients. In its broadest sense the team should include all individuals who participate in the direct and indirect care of the acute stroke patient. All individuals who fulfill a specific role should receive feedback on their performance as well as patient outcome. Therefore, when developing systems, documentation procedures should be incorporated that permit system analysis, feedback, and the evaluation of quality indicators such as time to treatment.

Once the team has been assembled, the patient management systems are in place, and all involved have been trained, a series of practice cases or patient simulations should be instituted. This will expose previously unrecognized obstacles to rapid and efficient care. All efforts should be made to ensure a smoothly functioning system prior to treatment of the first case so that chances of a good outcome and a positive experience are maximized.

Initial success in patient management is critical to the development of team pride and sense of accomplishment. As this sense of accomplishment grows, acute stroke care principles and methods will be incorporated into the daily and routine practice patterns of all health care workers involved in stroke care.

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Figure 1A. Patient flow chart.

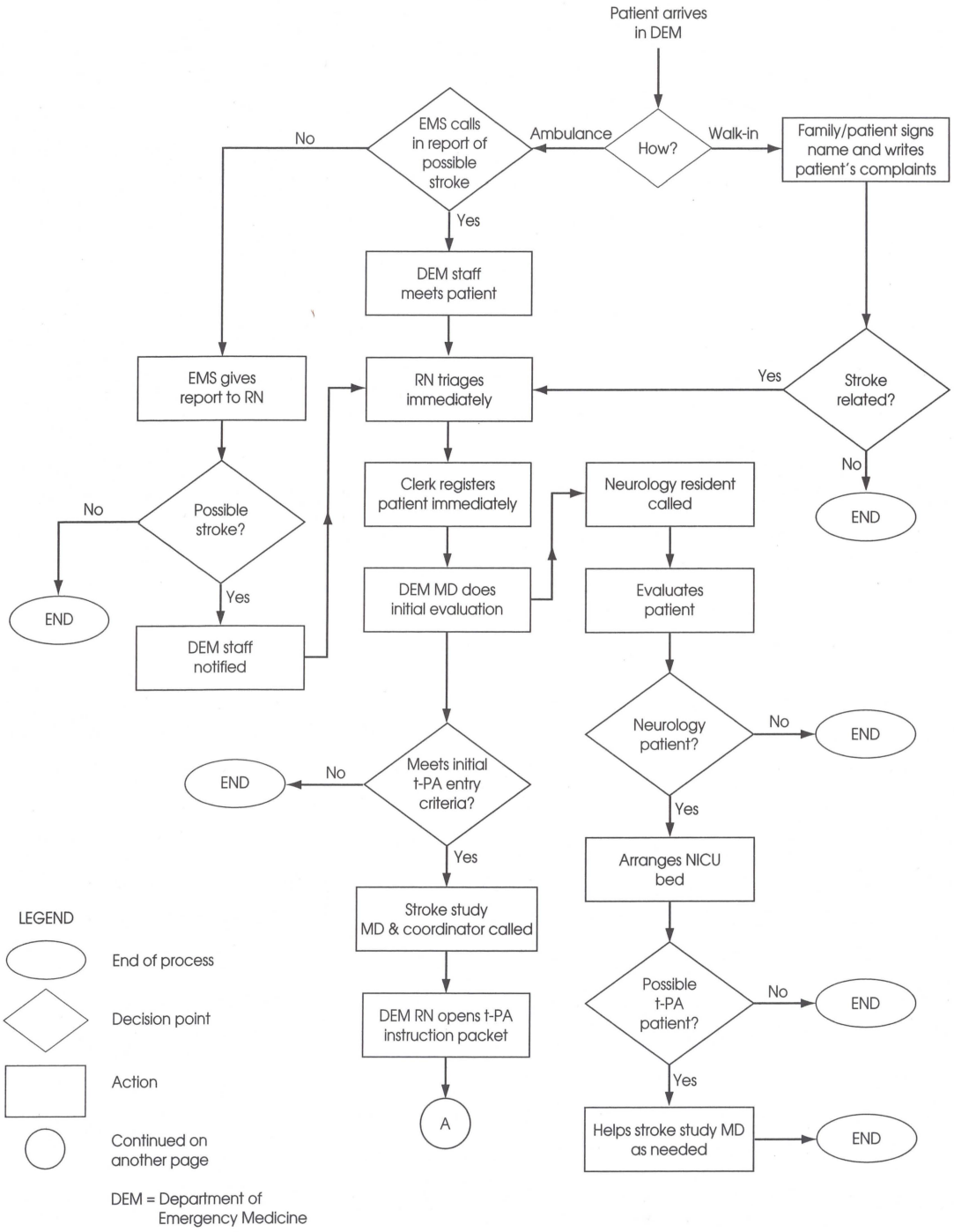
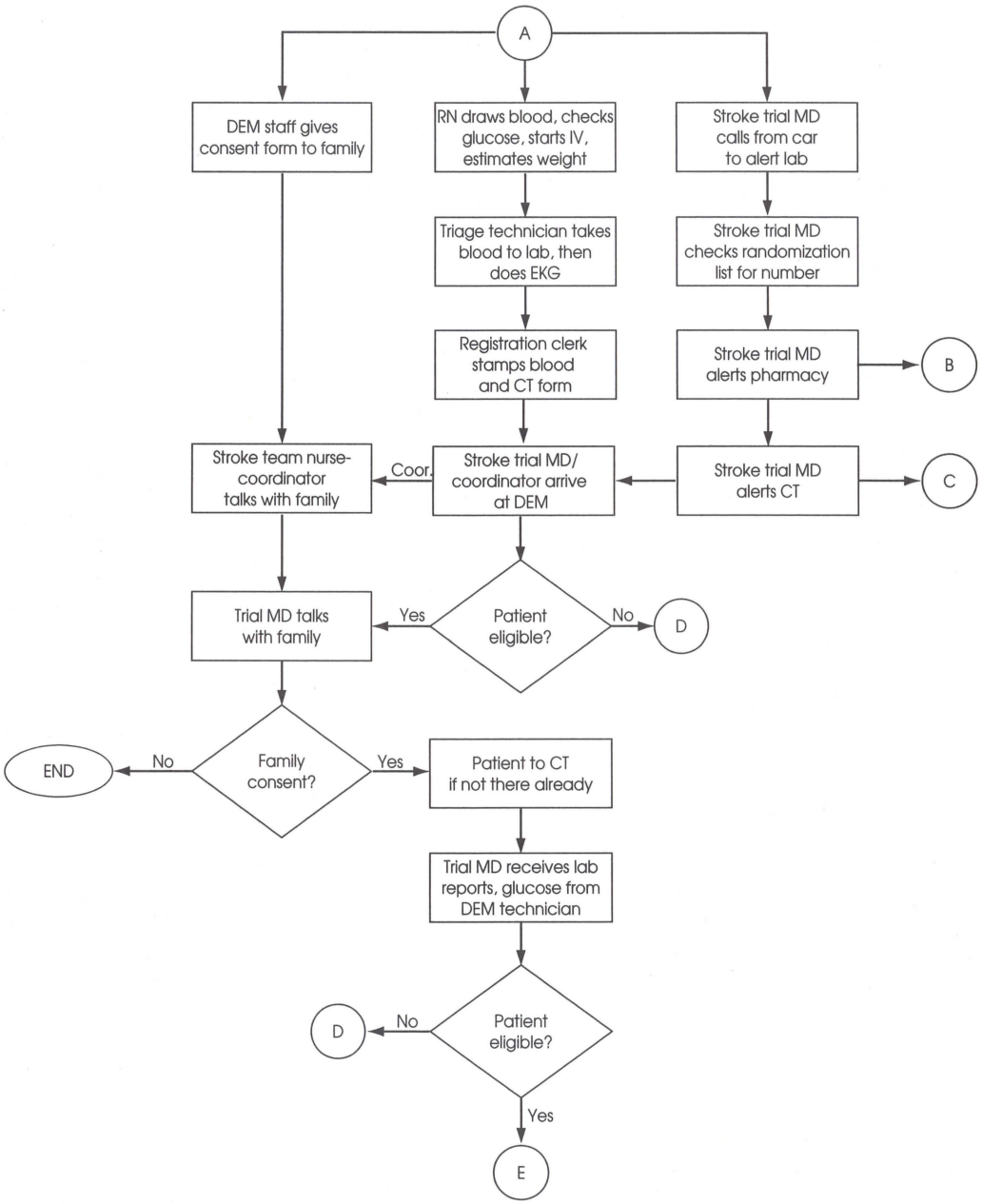


Figure 1B. Patient flow chart.



How to Create and Sustain the Continuum of Acute Stroke Care

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Background and Overview

There are several models for providing health care in the United States. Systems that succeed in providing high-quality and consistent care for patients with acute stroke will be those that assure physicians' autonomy in managing each individual patient. Extending the quality and consistency of care in single systems to multiple health systems throughout the United States will be greatly facilitated by the existence of a national stroke database, standardization of care, and uniform measurements of outcome.

Creating the Continuum of Acute Stroke Care in an Integrated Health System

Stroke neurologists and stroke nurses can join forces to team up with key people ("champions") in the emergency department (ED) and form on-call acute stroke teams. These teams would provide coverage 24 hours a day, 7 days a week, 365 days a year to the ED, hospital, and community. An on-call schedule can be developed each month, coordinated by one of the stroke nurses. A physician (stroke neurologist, stroke fellow, or emergency physician) certified in the NIH Stroke Scale (NIHSS) (1) would always be on call along with a nurse.

A dedicated team-paging system for stroke can be programmed for the stroke team pagers. Considerable time must be spent to build an understanding of acute stroke treatment with different services and departments that form key components of the acute stroke system: ED triage nurses, ED staff and residents, radiology and neuroradiology staff, CT technicians, pharmacy administrators and pharmacists, technicians who perform emergency laboratory testing, acute stroke and intensive care unit nurses, nursing administrators, hospital administrators, intensivists, and neurosurgeons.

Regular inservice training and flow-charting of each step in the treatment of acute stroke must be performed, reviewed, and continually revised and improved upon with the focus on efficiency. In addition, major efforts should be made to educate members of the emergency medical services (EMS) and the general community about stroke risk factors and warning

signs and about the use of the 911 emergency system. The education program will require a dedicated telephone line and e-mail address. Continuing medical education programs specifically for acute stroke recognition and management must be provided for emergency medical technicians (EMTs). The EMS link in the chain of stroke survival should be emphasized and reinforced with the old adage: "The chain is only as strong as its weakest link."

Within an integrated health system (IHS), potential patients and the members of the IHS should receive newsletters that provide education about stroke, emphasizing the importance of rapid assessment and treatment, and the need to recognize stroke risk factors and warning signs. Stroke must be presented as a 911 emergency, analogous to severe burns and head trauma. Personnel in every urgent care access site within the IHS should be trained to recognize stroke symptoms, triage acute stroke patients, and activate the acute stroke care system. Easily understood one-page screening checklists can be posted in the ED triage area to facilitate patient screening.

The model IHS recognizes that in systems for acute stroke management and treatment no one person can accomplish all that is required. Hence, a system approach is critical to success. The IHS enhances the care for stroke patients by combining the efforts of many individuals with a wide range of skills: neurologists, ED staff, and EMTs in the community.

Our experience at Henry Ford Hospital is that several months are needed to prepare for treating acute stroke patients. The steps required include training personnel to rapidly identify stroke patients within the ED, training stroke physicians to use the NIHSS, publicizing the acute stroke treatment system, setting up a stroke education program for the public, and initiating inservice training, practice trial runs, and regular meetings to discuss the protocol, maintain enthusiasm, and foster teamwork.

As the acute stroke treatment system is developing, personnel in the system should meet regularly to review current and optimal practice and to monitor integration of the stroke system within the larger health care system. For instance, since giving t-PA to eligible stroke patients reduces the length of hospital stay and increases the number of patients discharged to their homes rather than to a rehabilitation unit or nursing home (2), there may be justification to shift resources within the larger health care system to facilitate development of the acute stroke care system.

Maintaining the Continuum of Acute Stroke Care in an IHS

Establishing a system for maintaining, improving, and expanding the continuum of acute stroke care within a health care system will not be simple or inexpensive. Permanent, rapid, and effective linkages are needed to maintain a continuum of stroke care that encompasses:

- **Stroke education and awareness campaigns** ➔ Community response to stroke
- **Community** ➔ use of 911
- **911** ➔ rapid response by EMS
- **EMS** ➔ rapid transport to hospital

- **Hospital** ➔ access to expert stroke care
- **Expert stroke care** ➔ access to rapid diagnostic tests (CT, laboratory tests)
- **Hospital resources** ➔ treatment and monitoring after treatment

To develop new linkages, it will be critical to:

- Show value
- Demonstrate high quality
- Demonstrate efficient care at low cost

The major goals for the new system of linkages are to:

- Maximize the number of patients receiving effective care
- Minimize the risk involved

Developing local standards of care may be one way to begin establishing an acute stroke care system. It may be useful to start within a hospital system and then *grow outward*—to the community, to the county, to the state, and eventually to a regional or even national level of care. Within the hospital, the process can begin with conducting more physician education courses about acute stroke. A hospital system can be expanded to the community by providing stroke expertise on call to multiple hospitals that may agree to use the same paging system to notify physicians. Communication between hospitals can be encouraged. For example, the same courses for inservice training can be given to personnel at different hospitals. Ongoing communication will help ensure timely patient evaluations and timely acquisition of clinical data needed to identify optimum patient care in the acute stroke setting. The communication will also identify those key people who will become the champions for rapid acute stroke care.

Keeping the acute stroke care system as simple as possible (e.g., a "one call does all" stroke beeper system) is key. Shifting toward disease management rather than staying focused within departmental/divisional walls will assist in establishing collaborative practice patterns. Linkages to satellite sites within larger health systems will be needed. These linkages could (a) include hands-on skills workshops for continuing medical education credit provided by established stroke centers and professional societies (e.g., American Academy of Neurology); (b) increase multidisciplinary practices that involve internists, intensivists, neurosurgeons, and emergency physicians; and (c) promote "bundling" acute stroke care with other acute neurological/neurosurgical/trauma care plans. Barriers to simplifying and defining standards must be identified and addressed. Because national guidelines do not always change physician practices, local plans with local champions are needed. Practitioners in the community may not want to be told what to do, as has been the case in the past with other top-down approaches. Medical professionals should be offered several alternatives, creating an environment where there are real opportunities for participation.

"Reverse gate-keeping" in a managed care environment, which allows complete access to stroke experts early in the course of an acute stroke, may prove to be an effective model for stroke care.

One way to treat more patients effectively, in both rural and urban areas, may be acute

stroke care via telemedicine. Telemedicine for stroke is currently unproven, but holds promise as a technology-intensive rather than people-intensive method of providing rapid, expert acute stroke management and treatment expertise for hospitals and EDs with available head CT scanning but limited access to stroke experts. Telemedicine could provide access to an acute stroke treatment system for more patients, would help train physicians as they are treating the patient, and would be cost-effective. Interest in telemedicine is growing nationwide. It may provide the needed link to rural and urban care facilities lacking rapid access to appropriate specialists (e.g., neurologists and neuroradiologists). Further, telemedicine offers a means to centralize medical specialists in an environment more conducive to teaching and research. Teleradiology and telepathology have already been approved for reimbursement in different systems. Telemedicine for stroke is a new application for existing technology that ultimately could provide a rapid global response system making optimal use of critical resources.

Developing an interactive medical record for each acute stroke patient and every patient at risk for stroke within a health system would facilitate accurate relay of real-time patient information. This information might include standardized, quantitative stroke scale scores and live video of functional assessments, neuroradiological imaging, laboratory studies, protocols, and care maps. Data could be transmitted from the patient's current location to the facility where care will take place (local physicians or regional experts). Primary prevention strategies, secondary prevention measures, acute interventions, and neurorehabilitative protocols could be implemented on a more widespread and standardized basis. Further, use of this technologically based system could easily enhance clinical trials (3), testing hypotheses related to lay and professional education, acute intervention, prevention, and the poststroke period. Thus, rigorously and scientifically acquired data could be accumulated much more rapidly than has been possible previously, hastening the advancement and refinement of care for patients.

Summary

Most effective behavior change requires alteration of the environment in which the system functions and in which care is provided. Education is often necessary but, by itself, usually insufficient. Effective behavioral and system change usually requires a combination of changes in administration, regulation, financial incentives, and information feedback.

The goal is to provide the highest level of acute care for stroke patients as quickly as possible.

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Determining Acceptable Outcomes of Acute Stroke Care

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Quality improvement in our health care system is necessary and is being demanded by patients, payors, and health care providers. Stroke spans the continuum of health care, from prevention to long-term rehabilitation, and is an ideal model for the development of quality improvement indicators.

This chapter will serve as a first proposal for key indicators to assess acceptable outcomes of acute stroke care. These indicators may apply to small groups of patients at one particular institution or to a region that encompasses many institutions. The indicators are arranged according to the timing of particular events in the course of caring for an acute stroke patient (1,2), and will cover all four domains of measure: clinical, functional, patient and family satisfaction, and cost.

Key Indicators to Measure in the Prehospital Setting

- Presence of community education programs to inform the public and physicians about local prehospital systems available to expedite the treatment of acute stroke.
- Recognition of stroke by patients and bystanders.
- Use of emergency medical services (EMS) systems (911) by patients thought to have acute stroke.
- Assignment of high priority (similar to that for myocardial infarction and serious trauma) to care of patients with possible acute stroke by EMS dispatchers and EMS personnel.
- Presence of programs to train EMS personnel to recognize and respond to acute stroke.
- Recognition of stroke and pre-notification of receiving emergency department (ED) by EMS personnel prior to arrival.

Key Indicators for Events Occurring in the ED

- A stroke system prepared for rapid response at all times—24 hours a day, 7 days a week.

- An available protocol for acute stroke response and an ED staff practiced in all aspects of the stroke treatment algorithm.
- Awareness by ED staff that stroke is an emergency as important as myocardial infarction and serious trauma.
- Measurement of the time from arrival at the ED to the first ED evaluation by a physician.
- Measurement of the time from patient arrival at ED until the acute stroke system is activated or until a stroke team receives notification.
- Availability of CT scanning 24 hours a day.
- Measurement of the time from patient arrival at ED to CT scan.
- Rapid availability of the results of emergency tests required for the evaluation and treatment of acute stroke.
- Measurement of the time from patient ED arrival until the first contact with acute stroke system personnel.
- Presence in ED of physician with designated skills, experience, and training in treatment of acute stroke.
- Presence of physician with training that meets established criteria for skills necessary to interpret head CT scans required prior to initiating treatment of patients with acute stroke.
- Measurement of the annual number of patients with acute stroke treated in the ED.
- Measurement of the annual number of patients with acute stroke for whom evaluation is completed within 3 hours of stroke onset.
- Availability of pharmaceuticals for treatment of acute stroke on an emergency basis.

Key Indicators for Events Occurring in the Hospital

- Availability of stroke care guidelines and a dedicated acute stroke care unit.
- Availability of expertise for treatment of intracerebral and subarachnoid hemorrhage.
- Availability of acute stroke care unit or intensive care unit required for patients with subarachnoid hemorrhage or intracerebral hemorrhage, and for patients with acute ischemic stroke who have received thrombolytic therapy.
- Presence of appropriate protocols for management of blood pressure.
- Prophylaxis required to prevent deep vein thrombosis.
- Initiation of established protocols and programs for secondary prevention of stroke within 24 hours of hospital admission.
- Presence of procedures and diagnostic capability for accurate and complete reporting of treatment complications, including any intracerebral hemorrhage following initiation of thrombolytic therapy.

- Measurement of stroke mortality rate.
- Measurement of average length-of-stay for acute stroke patients.
- Presence of procedures for prompt recording of data needed to document resource utilization.
- Presence of procedures for accurately documenting the costs for acute stroke treatment.
- Presence of procedures to record discharge status for acute stroke patients.
- Presence of procedures to record measures of patient satisfaction.

Key Indicators for Events Occurring After the Patient is Discharged From the Hospital

- Availability of a full range of rehabilitation services to meet the diverse needs of recovering acute stroke patients.
- Procedures to assure performance and recording of standard measures of functional capacity in a high proportion of acute stroke patients at the time of discharge.
- Reports that include a standard measure of patient outcome available to all personnel involved in the entire chain of survival for treatment of acute stroke patients.
- Presence of methods to analyze acute stroke patient outcome data and implement appropriate changes in the acute stroke care system required to improve the quality of care.

Key Indicators for System-Wide Issues

- Measurement of the number of designated stroke treatment centers.
- Use of a protocol for coordination of patient referral and patient care among centers in a region.

A minimum set of key indicators would be less cumbersome to pursue and would serve to initiate the complex process of quality improvement. This minimum list should consider patient safety to be of paramount importance, and it should assess large impact issues and indicators for which reasonably reliable measurement tools exist. This minimum list might include:

- **Prehospital care:**
  1. Adequate ability of public and medical professionals to identify stroke and activate the acute stroke care system.
  2. Appropriate use of EMS (911) acute stroke system.
- **ED care:** Time from arrival to evaluation and treatment is appropriate.
- **Hospital care:** Stroke care protocol is available and implemented for a large proportion of acute stroke patients.
- **Postdischarge care:** Standard measures of patient function are recorded and analyzed.

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Will the Identification and Treatment of Acute Stroke Add Value?

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Introduction

To be effective today, disease management must assure outcomes that will create value for the patient by raising the quality of care while maintaining or lowering the costs. Quality alone is no longer sufficient to garner support for a treatment plan in the world of managed care. If the treatment is not affordable, its quality will probably not make it saleable or useable by our patients and their families.

Reimbursement Transition From Fee-for-Service to Capitation

The majority of payments for health care in America come from third-party payors—including government for Medicare and Medicaid recipients and insurance companies or HMOs for commercial patients. The decision to cover a particular service is usually based on two criteria: (1) is it nonexperimental, and (2) is it FDA approved? Based on these criteria, the treatment of acute stroke with t-PA should be a reimbursed service. However, the medication and treatment procedure is only one part of the continuum of stroke care. There are numerous steps in the early identification and transport of an acute stroke patient to an appropriate treatment facility. We must persuade third-party payors to understand the importance of each of these interconnected steps and seek funding from them to offset the costs.

As we move from a fee-for-service environment to a capitated HMO payment mechanism for many of our patients, the delivery team members must take the financial risk for providing this service. A capitated payment usually provides for total care for all episodes of disease as well as health maintenance. Consequently, the delivery team must deliver all care in the most cost-effective way so that there will be dollars remaining to cover the identification and treatment of acute stroke when such is required for an HMO patient. It is also important to note that slowly but surely Medicare and Medicaid systems are moving from a fee-for-service payment mechanism to a capitated structure.

Therefore, these same challenges will ultimately apply to most of our patients regardless of their health care reimbursment mechanism. The questions explored by the Health Care Systems Panel included:

- Does the delivery team of health care professionals believe that the protocol for identification and treatment of acute stroke adds value to the patient and the system if implemented?
- What are the cost savings that will offset the additional costs of this new treatment?

Summary

All disease management processes have costs associated with them that must be covered by some reimbursement process. Designing a treatment process and testing its validity is the important first step toward ensuring this reimbursement. This has been accomplished. Understanding the importance of the treatment process and learning how to incorporate it into our medical practices is the next step. This is the primary goal of this monograph. Recognizing that the medical management process adds value to the patients being cared for by an informal or formal health system, and covering the costs of such, is the final step in assuring the best possible care for the largest number of people in America.

Public Education Panel

Overview: Public Education

The Importance of Patient and Public Education in Acute Ischemic Stroke

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Efforts to change the perception of stroke from that of an inevitable and untreatable occurrence to that of a treatable medical emergency fall into two categories. The first focus of change is to maximize the ability of the medical system to recognize and appropriately treat stroke patients urgently. This approach has been described at length elsewhere in this monograph and was used successfully to recruit patients in the recent NINDS t-PA Stroke Study. Patient recruitment in that trial was considered a success. However, exclusion data from the trial indicate that of the more than 17,000 patients evaluated at an emergency department (ED) within 24 hours of symptom onset, only 3.6% were eligible for treatment (1). Using a similar measurement, the goal for emergency system reorganization could be to increase urgently treatable acute ischemic strokes to 10% of those presenting within 24 hours of symptom onset.

The second and perhaps most challenging focus of change is to educate the general public to better utilize the health care system in response to acute ischemic stroke symptoms. A review of the literature describing stroke presentation (Tables 1 and 2) demonstrates vividly that the majority of the general public does not seek health care immediately in response to stroke symptoms. Many of the specific factors that cause delays in seeking emergency care will be discussed in the papers from the Public Education Panel in this monograph. Identifying these factors and applying the principles of reaching large audiences with an appropriate message represent the "work" of patient and public education professionals. A proposed goal for this second focus would be to increase to 15-20% the rate of urgently treatable stroke patients seen in the ED (an additional 5-10% over the increase projected with emergency system reorganization alone).

Some caution needs to be used in interpreting these targeted goals. The timeframe for evaluating the goals may be different depending on the targeted strategy. Measuring the effects of emergency system change could probably begin as soon as possible. This would allow for some collection of baseline data. Experts

Table 1.
Hospital arrival times.

Study (Ref. No.)	Number of Patients	Stroke Onset-to-Arrival Time‡
Alberts (14) 1990, US	457★	42% < 24 hrs
Barsan (17) 1993, US	1,159★	59% < 3 hrs
Feldmann (18) 1993, US	96★	50% < 4 hrs, 4 hrs median, 13.4 hrs mean
Barsan (19) 1994, US	1,116★	77% < 6 hrs
Kwiatkowski (15) 1996, US	42†	10 hrs median
Kothari (9) 1996, US	163★	N/A
Morris (16) 1996, US	112★	54% < 3 hrs
Kay (20) 1992, Hong Kong	773★	63% < 12 hrs
Harper (7) 1992, Leicestershire, England	374★	25% < 2.5 hrs, 6 hrs median
Ferro (21) 1994, Lisbon, Portugal	309★	42% < 6 hrs, 9.5 hrs median
Anderson (23) 1995, New Zealand	1,008★	50% < 4 hrs, 4.3 hrs median
Fogelholm (22) 1996, Finland	363★	43% < 6 hrs, 10 hrs median
Kolominsky (24) 1996, UK/Germany	503★	UK: 41% < 6 hrs, 7.1 hrs mean Germany: 56% < 6 hrs, 5.6 hrs mean
Lago (25) 1996, Spain	641★	46.2% < 3 hrs, 3 hrs median

★ Combined ICH, SAH, and ischemic strokes or not specified.
† Total ischemic strokes only.
‡ Shortest possible time reported for ischemic or, if not specified, combined stroke types.

in community education, however, will argue that, although patient behaviors can be changed, the process is slow. It would be appropriate to measure the effects of educational programs 3-5 years after they have been put into place. Another factor to be considered when establishing targeted goals and time-frames for their evaluation is the possible future development of additional stroke therapies with broader time windows for treatment.

Using the number of treatment-eligible patients as a measure of success in education campaigns has already been done for other diseases. Often the stroke experience is compared with earlier experience in treating acute myocardial infarction (AMI). The goal of increasing to 20% the rate of treatable acute ischemic stroke patients presenting to hospitals (10% increase from system reorganization and 10% from public/patient education) can be compared to current data from the National Registry for Myocardial Infarction 2 (NRMI-2). In

Table 2.
Variables affecting stroke presentation (early = early presentation; late = delayed presentation).

Study (Ref. No.)	Number of Patients	Patient Characteristics	Acute Stroke Response
Alberts (14) 1990, US	457*	Early: ICH or SAH type Late: ischemic stroke type	
Barsan (17) 1993, US	1,159*		Early: call to 911 Late: call physician Early: daytime onset Late: nighttime onset Early: stroke at work Late: stroke at home
Feldmann (18) 1993, US	96*	Early: severe or sudden Early: symptoms recognized	
Barsan (19) 1994, US	1,116*		Early: call to 911 Early: daytime onset
Kwiatkowski (15) 1996, US	42†		Late: call physician
Kothari (9) 1996, US	163*	Early: symptom recognition Late: no symptom recognition	Late: family witness Early: community hospital
Morris (16) 1996, US	112*		
Kay (20), 1992, Hong Kong	773	Early: ICH or SAH stroke type Late: ischemic stroke type	
Harper (7) 1992, Leicestershire, England	374		Late: living alone Late: family witness Late: nighttime onset
Ferro (21) 1994, Lisbon, Portugal	309	Late: no symptom recognition	Late: first call to physician Late: family witness Early: daytime onset
Fogelholm (22) 1996, Finland	363	Late: ischemic stroke type	Late: first call to physician Late: family witness Late: nighttime onset Late: weekend onset
Kolominsky (24) 1996, UK/Germany	503	Early: severe or sudden	
Lago (25) 1996, Spain	641	Early: ICH or SAH stroke type Late: ischemic stroke type Early: severe or sudden	

* Combined ICH, SAH, and ischemic strokes or not specified.
† Total ischemic strokes only.

this database, covering the period from July 1995 to June 1996, 122,792 nontransferred AMI patients in the United States were identified; 66% did not achieve acute reperfusion while 33% did achieve some acute reperfusion (27% thrombolysis, 7% alternate interventions) (2). The differences between stroke and AMI are numerous and include disease incidence, variables affecting symptom onset, treatment options available, and treatment time windows. Nonetheless, the similarities of the populations at risk and recent experience with evolving therapy allow meaningful comparisons between AMI and stroke.

The timing of system reorganization and patient and public education programs is itself somewhat controversial. Should these two strategies be separated and implemented serially one at a time? If implemented serially, which of the two strategies should be implemented first? Or perhaps they should be introduced nationally in parallel, allowing local factors and standards to determine the course of implementation.

Scenarios in which the systems are changed via traditional, academically driven professional education prior to public expectation unfortunately depend on widespread acceptance by clinicians of the need to change. Ultimately, such a process is dependent on some overseeing body to determine when the system is ready to implement the second phase. Another problem with this approach, which has been seen in clinical trial recruitment and, to some degree, in the evolution of cardiac treatment, is that teaching new standards of care even with wide acceptance does not ensure that there will be actual changes in health care delivery systems. A sufficient number of patients eligible to receive new treatments must seek care in order to develop and refine new systems.

There are several potential problems with creating public expectation and demand before the treatment standard is fully established. This situation can be driven by the "market." Hurried, haphazard placement of new protocols in conjunction with or just prior to marketing of new services may occur. The nature and/or quality of care provided may vary markedly among medical facilities within the same community. In today's competitive health care environment, cutting edge care can become just another marketing strategy instead of a recognized scientifically driven advancement. In less competitive communities, a national or local public education campaign alone would probably have little noticeable effect on acute stroke treatment. Changing behavior with public education is a *slow* process.

Ultimately, the most acceptable timing would be the simultaneous introduction of new treatment standards and public education programs to decrease the time from symptom onset to hospital arrival and treatment. Change is often painful, and recognizing the need to change, if left solely to a traditional continuing education model, could be delayed for years. As a result, actual change in patient care delivery would be further delayed. Public education would inject the additional pressure of consumer demand and accelerate the process that each center

must undergo to embrace and properly plan new systems for delivery of care. During this difficult process, it is important to remember that the ultimate goal for health care professionals is to safely improve the outcome for every patient cared for in our systems.

Previous Educational Campaigns

Previous educational programs for stroke have, in general, suffered from a lack of organization and motivation. In the not so remote past, most public education focused on stroke prevention rather than on stroke treatment. Multiple prevention and risk factor awareness resources were available but were often overlooked in the clinical setting in order to use valuable patient contact time to focus on "treatable" diseases. Public education programs stemming from stroke clinical trials and focusing on treatment have reported some success in increasing trial enrollment or decreasing delays in treatment (3). These efforts were local. It is not known whether any benefit was sustained after the stroke trial or program was concluded.

Evaluating the public's knowledge of stroke has been attempted (4-6). Specific results of these efforts will be described in subsequent discussions. It is safe to say that considerable educational efforts will be required to ensure a knowledgeable public, as was the case for AMI. We hope that experiences from cardiac and other organized educational efforts will be useful in helping us create an effective educational campaign for the public and for stroke patients.

The Stroke Patient's Dilemma

Many stroke-focused researchers and health care providers believe that the process a stroke patient goes through when seeking health care is different from the process used by patients with other diseases. The available studies for review are limited in number and influenced by cultural differences and varying study methodologies. Despite this, important variables in the treatment-seeking behaviors of stroke patients can be identified. One such example is the important role played by witnesses or the first person contacted after the onset of stroke symptoms (7-10). However, a complete picture of the stroke patient's decision-making does not yet exist.

Changing treatment-seeking behavior is one of the most difficult challenges facing patients and professionals responsible for health education campaigns (11). Stroke may be an especially difficult challenge. Compared to AMI for example, stroke presents many more variables that can prolong the delay in seeking medical care (12,13).

The Message, the Audience, and the Medium

As in Madison Avenue mass marketing campaigns, the design, content, and execution of a public education campaign represents the greatest actual dollar investment. The success of a project depends on identifying "the best messages, the right audience, and the appropriate medium in which to convey the message." An acceptable balance between scientifically based

messages about stroke and what the public is capable of understanding needs to be identified. Factors that might motivate change in the population at risk for stroke also need to be identified and evaluated. The benefits of national versus local campaigns or combinations of both need to be further explored. But having answers to these questions is only half the equation. How stroke messages will be coordinated among the various agencies that provide patient and public education and who will support this effort with the necessary dollars for a successful campaign have yet to be decided.

In developing our strategies for patient and public education we might want to consider the sites where patients at risk for stroke receive their health care. Since the majority of potential stroke patients are already receiving medical care (6), one of the stroke education campaign targets could be to directly educate patients at risk who receive medical care at primary provider offices and clinics. The motivational message might emphasize the risk for disability. The symptoms of stroke would be taught to both patient and family and always in conjunction with the desired treatment-seeking behavior.

Once a patient has had a stroke there is a high risk that he or she will have another. A different level of stroke education could be introduced in this situation. Again, direct contact with stroke patients and their families by a health care provider in the hospital, ED, clinic, or primary care provider's office is needed to teach (and re-teach) the symptoms of stroke. Discussion of a particular stroke patient's symptoms will enable the likely witnesses of any second stroke to better recognize neurological change in the individual at risk. Why time is important in seeking health care for stroke should also be discussed. Finally, potential treatment options, risks, and benefits need to be introduced to enable the stroke patient and his or her family to make the best possible decisions should the need arise.

Programs like the one described above are needed today. As more time-dependent treatments for stroke emerge, all health care professionals encountering patients at risk for stroke need to be ready and able to assist patients and families as well as the public at large in making the best possible decisions and facilitating the best possible outcomes. Specific programs focused on treatment-seeking behavior should be used in combination with stroke prevention programs that already exist. Well-designed existing programs need not be discarded or changed, but rather should be incorporated in a master educational campaign so that they can be used more widely. Much cooperation will be needed among interested groups that stand to gain from improved stroke patient outcome. The resulting success of such a coordinated effort will have wide-ranging impact on both the human and financial toll of stroke.

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Lessons From Current and Previous Stroke Public Education Campaigns

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In light of the recent approval of t-PA for the treatment of acute ischemic stroke, the subject of public education about stroke has assumed an even larger significance. We have always known how important public education is, but it is especially critical now, considering the temporal and logistical limitations that accompany the use of a drug like t-PA. Patients are eligible for treatment only within a narrow window of time after symptom onset, and patients in some parts of the country do not yet have access to the drug and the screening tests required for its use. Therefore, the challenge we face is that public education, defined as the conventional one-way transmission of information, is necessary but will not be sufficient for this particular campaign.

Achieving effective stroke prevention and treatment will take more than the latest medical advances. To draw an analogy, our current situation is equivalent to having a classy, modern airplane without any onboard navigation system. The technology for acute treatment of most ischemic strokes exists, but it will not achieve its full potential until the proper conditions are in place.

Public education is the best tool we have to put these proper conditions in place. It is the navigation system that will guide the country in fully and appropriately using technological advances like t-PA.

Establishing the importance of public education among ourselves is the easy part. Instituting a campaign that conveys that importance to the general population is a different matter altogether. If a campaign is to be waged, several questions need to be asked regarding its planning, execution, and evaluation. Who are we trying to reach? How do we go about reaching them? What exactly are we trying to teach them? And, perhaps most important, how do we structure our education efforts so that we ultimately change behavior?

The following are some representative activities that the National Stroke Association (NSA) has undertaken or observed during the last few years. I believe we can draw some overarching lessons from them.

Stroke Prevention Project

In May of 1995, the NSA conducted its Stroke Prevention Project as part of the activities associated with that year's Stroke Awareness Month. Educational seminars were held in five cities—Minneapolis; Tampa; Washington, DC; Lexington, Kentucky; and Pittsburgh—with participants drawn by stories featured in local television, radio, and newspapers. The purpose of the seminars was not only to educate those who attended, but to gauge the effectiveness of our message.

Each participant responded to a survey prior to the start of the session. This survey provided a benchmark to measure the participants' knowledge about stroke. A local neurologist and an NSA board member (Jacquelyn Mayer Townsend) then spoke to the attendees about risk reduction and symptom recognition. Once the seminar was finished, participants were asked to complete another survey, which measured how much they had learned.

Through media placement and the wording on our advance press release, we targeted people over the age of 50 because of their greater stroke risk. While our seminar certainly succeeded in that respect, a disproportionate number of women and Caucasians attended. Roughly nine in ten who attended were white, and seven in ten were women. How this composition affected the data is uncertain.

As for the results, what we found was mildly encouraging. Beforehand, only 8.5% said they knew "a lot" about strokes. When the same question was posed to respondents after the seminar, 70% said they knew "a lot" about stroke.

The level of knowledge about the factors contributing to stroke also increased significantly as a result of completing the seminar. This was especially true for factors such as heart disease (38.2% in the preseminar survey compared to 72.6% in the postseminar survey), diabetes (32.8% compared to 83.5%), and excessive alcohol consumption (42.1% compared to 76.9%).

What did we learn? While we must be cautious about drawing firm conclusions, the fact that a self-perceived void had been (at least) partially filled in a short time was not a trivial result. This project also suggests that more followup and analysis are required if we seek to reliably measure learning outcomes and levels of awareness.

Clinical Trials Acceleration Program

The Stroke Prevention Project was encouraging in that it showed an increase in knowledge levels, but it didn't answer the larger and more important question, "Will it change behavior?" Although there is no conclusive evidence, results acquired through selected studies and NSA's Clinical Trials Acceleration Program (CTAP) seem to indicate that education can make a difference.

Thus far, CTAP has provided more than 300 site hospitals with training, consultation, and the tools to implement an education campaign. Hospitals armed with this information proceed with the next step—teaching the public about symptom recognition and the need for rapid treatment.

This educational push has translated into some heartening results in participating hospitals. In clinical trials held in conjunction with the NSA, patient goals were met three to five times faster than in studies that did not use the same strategies and educational resources. The best evidence for this comes from one trial that enrolled patients from 17 NSA-supported sites and 18 non-NSA-supported sites. Over a 12-month period, a total of 43 patients had been enrolled, 35 of whom came from the NSA-supported sites and eight of whom came from the non-supported sites.

At Duke University, Dr. Mark Alberts and others found similar results during an initial trial of t-PA. They hypothesized that educational efforts aimed at the public and health care professionals may increase recognition of stroke symptoms and reduce patient delays in seeking health care. The Duke study undertook public education through a multimedia approach. Local television, radio, and print stories focused on the use of t-PA for acute stroke and the need for early treatment. Physicians and other health providers were approached through special training, seminars, and correspondence. These medical professionals found that after their educational efforts, more than 85% of patients with cerebral infarction presented to their facility within 24 hours of symptom onset, compared with less than 40% prior to the start of the program.

Gallup Surveys

This year, the NSA took a broad look at the impact of our education efforts by conducting a national Gallup poll on stroke. This poll was similar in structure and content to a Gallup poll we conducted in 1991. The idea was that a comparison of the two surveys should give us a reliable indication of how stroke awareness and knowledge had changed over the course of 5 years.

While these polls don't directly fit under the heading of an "educational campaign," they do provide us with some baseline numbers against which we can compare other results. The numbers are also notable because they draw on a large random sample of respondents, and may therefore be an accurate reflection of the level of stroke knowledge in this country.

The Gallup polls showed us that stroke remains a mystery to many people. Americans had difficulty in identifying conditions that put them at risk for stroke. Only 35% of those surveyed in 1991 could identify hypertension as a risk factor, a number that had improved to 43% by 1996. We also found that less than 20% of people in 1996 knew that other risk factors such as smoking, high cholesterol levels, and obesity contribute to stroke. Symptom recognition has improved, but it is still limited. The 1996 poll indicated that only six in every ten adults over the age of 50 knew that weakness or numbness is associated with stroke. Even more sobering, just 15% of those surveyed identified dizziness and 12% named severe headaches as symptoms.

Conclusions and Recommendations

Obviously, the cases I've cited here are not exhaustive, nor is the NSA the only organization involved in stroke and stroke-related public education. The American Heart Association, the National Institute of Neurological Disorders and Stroke, and many other private, charitable, corporate, and governmental agencies have a strong track record in this area. I invite their representatives to comment on, broaden, or even dispute my conclusions or recommendations. That dialogue will be more useful than any single presentation.

I believe the public education landscape contains some good news and some bad news. The good news is that we know from other well-executed campaigns that education *can* substantially change both knowledge and behavior. I would cite education campaigns on AIDS and breast cancer as two prime examples. Moreover, the Gallup results demonstrate significant improvement in most areas of stroke awareness. However, they also prove we still have a lot of work to do.

The more significant bad news, as I see it, is that we don't seem to have a firm handle on what works, with whom, and why. Gallup results are certainly useful, but they are blunt instruments for fashioning education strategy. Our CTAP results, though significant, may be too anecdotal for us to draw conclusions about an entire population or discrete segments of that population.

Worst of all, some studies (notably an analysis of many other studies conducted to assess factors influencing presentation time by heart attack victims) suggest that even complete and accurate knowledge doesn't necessarily translate into appropriate behavior. In view of the numbers of Americans who still smoke cigarettes, this conclusion shouldn't surprise us, but it is still discouraging to those of us who are trying to lead our fellow citizens toward healthier lifestyles and to quick action if stroke symptoms appear.

This brief analysis leads me to one overarching recommendation. I believe all of us would benefit from some new sophisticated research on behavior modification and/or a compilation of any research that has already been done. Many of my colleagues and I have seen no specific link between such research and nationwide public education. A digest of effective methodology and techniques would be an enormously useful departure point for future education efforts.

Once that step has been taken, I believe the agencies involved in the stroke initiative should use the results of that research to mount a coordinated national campaign focused not simply on transmitting information as most of us do now, but rather on changing behavior in target populations. We think we're doing that now, but our results suggest we need a new approach. Perhaps the beginning of that new approach will spring from the ideas and recommendations found in this monograph.

Lessons for Success in Public Education Campaigns

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This paper will outline five lessons for success gleaned from previous public health education campaigns.

Lesson 1: Public Education Works

It is commonly said that we can't change behavior, but this is simply not true. Evidence for this can be seen in a number of large-scale behavior changes witnessed over the past quarter century. One important example is the 50% reduction in smoking in this country. Another example is the rise in the use of automobile seat belts and child safety seats; over the past 20 years there have been dramatic improvements in the use of these safety devices. Utilization of mammography screening tests is a third important example. Between 1987 and 1992, the percentage of women over the age of 40 who received annual mammograms rose from 17 to 44%. This is an impressive change in behavior over a relatively brief period of time.

Other examples include reducing dietary fat and increasing the consumption of high-fiber foods. Unfortunately these trends seemed to have peaked in 1989 or so, but Americans are still eating a much healthier diet than was the case 15 or 20 years ago.

Condom use among male adolescents has increased dramatically in this country, from less than 15% in the pre-AIDS era to 50-60% in the current era. This change took place among a population that many believed would be extremely difficult to reach and influence.

A final example is the reduction in the incidence of sudden infant death syndrome (SIDS), a result of the successful public education campaign encouraging parents of newborns to turn babies on their backs to sleep. The lower incidence of SIDS is especially notable in Australia and New Zealand, although we are making a great deal of progress in this country as well.

Each of these are compelling examples of the fact that public education works. While it is certainly true that noneducational factors such as increased availability and decreased cost (in the case of mammography) and changes in public policy (in the case of seat belts) also play a role, the evidence is clear that the public can be educated effectively, and that behavior change does, in many instances, follow.

It is important to note, however, that public education tends to work slowly. In most of the examples cited above, changes occurred over a decade or more. And progress in getting stroke victims into emergency departments rapidly will also take time. It is simply unrealistic to expect overnight changes in behavior of this type. In addition, not all health behaviors are equally amenable to change or equally responsive to public health intervention efforts. For example, compare the differences in public behavior concerning SIDS and AIDS. SIDS-related behavior change has occurred very rapidly, and with a minimal level of educational intervention. In contrast, the behaviors we are promoting for AIDS prevention are complicated: they take place in highly emotionally charged situations and there are many social norms surrounding the behaviors. Preventing SIDS is vastly simpler.

Our national experience in promoting early response to acute myocardial infarction (AMI) may provide some indication of how long it will take to change behaviors related to rapid stroke response. The symptoms of AMI are more dramatic, and easier to communicate, than are symptoms of stroke. Unfortunately, overcoming that communication challenge is likely to slow down the rate of behavior change.

Finally, some behaviors or "offers" are easier to promote than others. Fortunately, the offer concerning rapid treatment of stroke is becoming more attractive all the time. Now that we know there are proven means of preventing some of the most feared consequences of stroke—such as long-term disability—the offer to seek medical help quickly will become far more attractive to the average American.

Lesson 2: Big, Comprehensive Programs are Most Effective

Effective public education campaigns include the largest number of information vehicles possible. The combination of print, broadcast, national and local news media, public service announcements, paid advertising, aggressive public relations efforts, dramatic depictions in the entertainment media, and collaborations with community leaders, retailers, care providers, and health plans will work better than smaller efforts focused on only several of these information outlets. The information environment today is highly cluttered. Only large, multidimensional programs have the capacity to rise above the clutter to convey our messages and successfully bring about behavior change. Each and every instance of communication can have a small effect, but the totality of myriad efforts generated in the public, private, and voluntary sectors will produce results and make a difference in the way the public responds to stroke.

Successful educational campaigns are typically multisectorial. The government cannot do it alone. Nor can industry or nongovernmental organizations. Only when we achieve synergy among organizations from multiple sectors will we really start to see change.

Lesson 3: "General Population" Isn't a Valid Definition of our Target Audience

Who do we need to reach to make a difference in the treatment of acute stroke? Unfortunately, even though we may need to reach everyone, we cannot simply educate the "general population." Different groups of people have different educational needs. We must segment the diverse general population into smaller, more homogeneous audiences. By tailoring our message to these different groups, in a manner that reflects their unique view of the world, we are more likely to succeed in delivering educational messages they will respond to.

Lesson 4: Education ≠ Motivation ≠ Behavior Change

The fact that education does not necessarily lead to motivation, and that motivation does not necessarily lead to behavior change, poses a quandary. How are we to carry out our mission if one element doesn't necessarily lead to the other? Health educators have long discussed the discontinuity between *knowledge, attitude,* and *behavior change* (the "KAB fallacy"). I suggest that we reframe the problem. Instead of thinking about *knowledge, attitude,* and *behavior change,* I suggest thinking in terms of education, motivation, and behavior change. Unfortunately, just thinking about the problem of changing behavior differently does not necessarily make the basic task any easier. It is still the case that we can educate a population and they may fail to change their behavior. We can even succeed at motivating a population and they may still fail to change their behavior. But I believe that by thinking more clearly about these discrete subtasks within the overall educational process we can start to make some concrete headway.

Education occurs when clear, simple messages are repeated often in many different venues. The communication challenges at this stage are to develop those clear, simple messages, and to ensure that the messages reach members of the audience with sufficient frequency and from a sufficient number of credible sources.

Motivation occurs when the perceived benefits of a behavior clearly outweigh the perceived costs. There are always costs associated with behavior change and sometimes there are benefits. Often, people simply don't see or understand that the cost/benefit ratio is desirable for them or in their best interest. Our challenge is to communicate about the behavior such that the perceived benefits are clearly understood to outweigh the perceived costs.

Behavior change is more likely to occur with education, motivation, *and* ability. By ability, I mean the acquisition of the skills—cognitive, physical, and social—that a person needs to make a particular behavior change. This will be a great challenge when the goal is getting people to come to emergency departments as soon as they recognize they are having a stroke. High-risk individuals (whose numbers are growing) and their family members and co-workers simply do not yet have the cognitive skills to make the proper conclusions about seeking treatment. Moreover, there are powerful social forces at play that cause people to avoid rapid responses. Part of our communication challenge will be learning how to simplify the cognitive and social skills and how to communicate them clearly and repeatedly.

Lesson 5: Effective Education is Both Theory- and Audience-Driven

Effective education is driven by both behavioral theory and good marketing research. Behavioral scientists have given us an important head start through the development of theories about behavior, motivation, education, and behavior change. We need to draw on specific relevant theories to guide us through different parts of the problem—including the knowledge-gain problem, the persuasion and motivation problem, and the behavior-change problem. Appropriate behavioral theories can provide critical insight into how to conduct an insightful "educational diagnosis" and how to structure potentially effective "educational" programs.

Good marketing research allows educational planners to "get into the minds" of target audience members. By understanding how audience members think and feel, educational planners can develop programs that specifically respond to the audience's unique perspective, thereby enhancing the odds of successful communication. Audience input, through focus groups, in-depth interviews, surveys, and a variety of other means, is the most powerful resource available to the program planner.

In summary, in an ideal world a stroke education campaign would involve the efforts of many different sectors of our society—governments and not-for-profit organizations, industry, and a broad spectrum of private sector concerns. It would target specific audiences and tailor efforts to their specific needs. And it would deliver education based both on behavioral theory and on what is in the minds of our target audience. This is the only formula for success that we have. It is not simple work, and it is certainly not quick work, but if we follow these basic principles, we will achieve incremental gains each step of the way and are certain to create a meaningful impact in the long run.

Seeking Health Care Following Stroke: Public Education

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Advances in the diagnosis, management, and acute treatment of stroke present us with the challenge of delivering care to a population that traditionally seeks care hours and even days after the event in a system that does not respond urgently to this disease process. In the past, early treatment interventions for stroke were not available and there was no incentive to seek immediate health care. However, recent evidence indicates that early intervention for stroke increases the chance for recovery and restoration of function (1). Therefore, it is imperative that persons experiencing signs and symptoms of stroke seek health care immediately to reduce disability and death.

The immediate goal for acute stroke care is to decrease the time it takes from stroke onset to initiation of acute medical intervention. This entire time is described as "delay time." Delay time from first symptoms and signs to the start of treatment has been studied in the cardiac population to determine changes needed to streamline care. These studies are helpful when trying to understand delay time in the stroke population. Knowledge of the factors influencing delay time and the decision-making process of stroke victims and bystanders will help create an effective public education campaign, which is the focus of this chapter.

Delay Time

Delay time—the time between the onset of symptoms and the start of medical intervention—has been well-studied in an effort to understand health-seeking behaviors. The literature on cardiac health-seeking behavior documents the various phases and characteristics of delay time. The six phases adapted by Alonzo (2) from Suchman's stages of illness (3) are outlined below:

- *Prodromal period.* The period between the initial awareness of a health deviation (prodromal symptoms) and the onset of acute symptoms.
- *Definition period.* The period of self-evaluation that occurs between the onset of acute symptoms and the seeking of lay advice.

- *Lay consultation period.* The period between the seeking of lay advice and medical consultation. If medical consultation is not sought, the period extends to the initiation of travel to the hospital.
- *Medical consultation period.* The interval between the start of medical consultation and the initiation of travel to the hospital.
- *Travel period.* The time spent traveling to the hospital.
- *Hospital procedural period.* The time spent in the hospital emergency department (ED) or in the admission office until definitive treatment begins. This phase includes patient admission procedures, initial medical evaluation, and diagnostic studies.

The sequence and amount of time spent in each phase described will vary with each individual. To reduce delay time, each period must be understood and specific problems addressed. Once the individual or the bystander has made medical contact, the acute stroke system is considered to be activated. It is then up to the system to decrease the time it takes to start the appropriate medical intervention. Therefore, understanding decision-making in the first three time periods is critical to developing an effective public education program.

Decision-Making/Delay Time

Typically, in the prodromal period the individual recognizes something is wrong. In the stroke population it is unclear what percent of patients are aware of their symptoms or that their health is impaired. Those with altered cognition following a stroke are at special risk of not recognizing symptoms.

The definition period that leads to attempts to seek help is a multidimensional process. The individual will recognize something is wrong. At that point he or she decides what may be wrong, how serious it is, and what to do about it. Determination of the problem will influence the perceived level of seriousness and the necessity of action. The action may include initiating self-treatment, seeking help from a family member or friend, or contacting a health care professional (family physician, clinic, or 911).

Moss et al (4) studied delay time in the cardiac population and concluded that three cognitive factors are required to make a decision to seek medical help: (a) perception of presenting symptoms, (b) appreciation of the meaning and seriousness of the symptoms (recognition), and (c) realization that medical help is indicated for the recognized and appropriately interpreted symptoms. Education programs should focus on these three factors to facilitate specific decision-making behaviors for the stroke population.

The lay consultation period may be even more important in decreasing delay time in the stroke population. If a friend or family member is consulted, the burden of making a decision is shifted to that individual. The lay person must determine if the problem is serious and what should be done. Therefore, understanding stroke and stroke symptoms, as well as the appropriate actions in response to stroke, becomes imperative in the lay population. Anecdotal information indicates that nearly all stroke

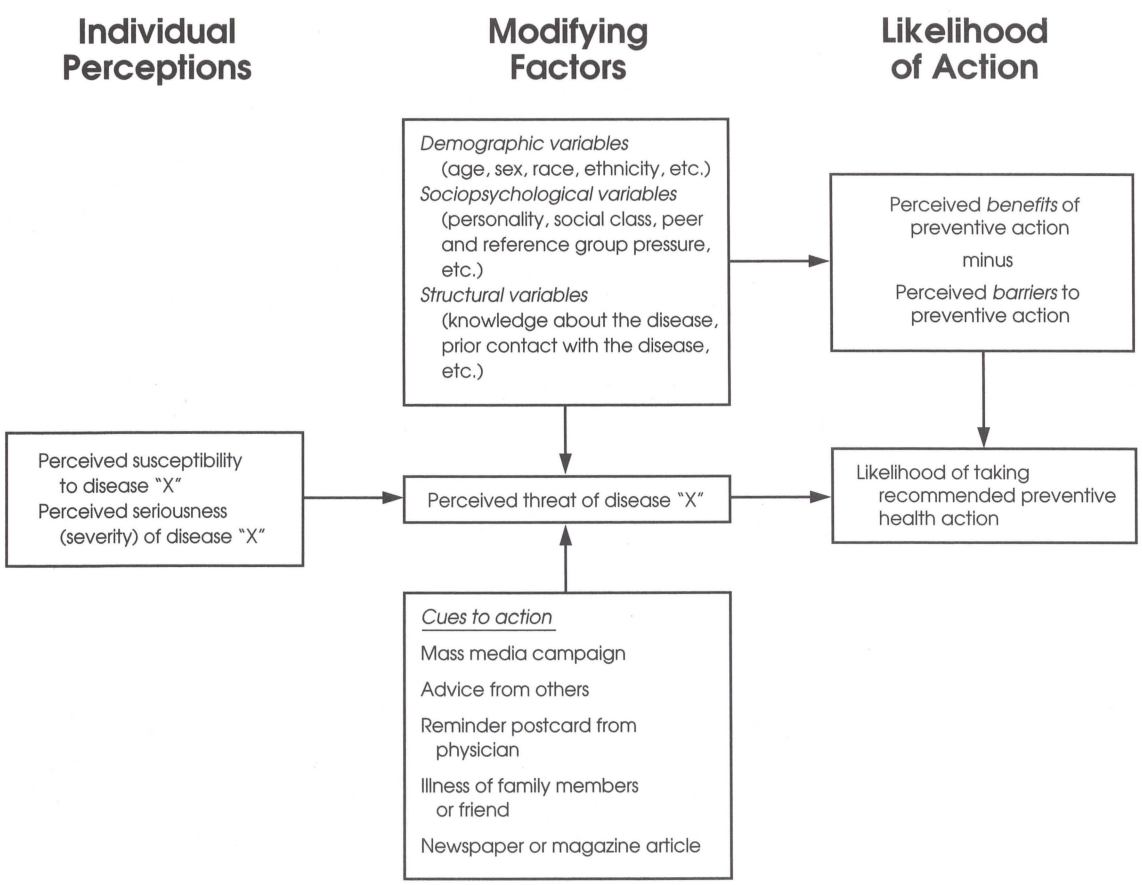
patients have help from another person when obtaining health care. Therefore, family members or close friends of those at risk for stroke must be a target in a public education campaign.

Health Belief Model

The Health Belief Model (HBM) is used as the theoretical underpinning for understanding health-seeking behaviors. The HBM evolved from the premise that each individual's perception of the world determines what that individual will do. The concepts of the model include the individual's perceptions of susceptibility to the disease, severity of the disease, and benefits and barriers associated with the choice of action that may prevent the disease process (Figure 1). The theory was developed to explain preventive health behaviors.

The second stage of the model is "illness behavior," described by Kasal and Kobb (5) and by Kirscht (6) as a person's actions when faced with acute symptoms. Illness behaviors include recognizing symptoms

Figure 1. The Health Belief Model.



and deciding whether to self-treat or seek medical care. The HBM theory represents a universal view of health behaviors. The HBM also relates psychological theories of decision-making, which attempt to explain actions in a situation presenting choices, to an individual's decision about alternative health behaviors (7). The HBM provides a framework for determining the predictive variables that influence health care choices of stroke survivors or their family members when they are faced with the signs and symptoms of acute stroke.

Delays in Seeking Health Care for Heart Disease

The problem of delaying health care is not unique to the stroke population. In the late 1960s when a high mortality associated with heart attack was identified, the delay time in seeking medical treatment was recognized as a critical factor (8). It was evident that if patients sought treatment sooner, lives could be saved by the advanced treatment options available. Over the last 20 years, the literature on delay in seeking health care has been exclusively in the domain of the cardiac population.

Assessments of the characteristics of individuals with heart disease who seek health care have been reported. The studies found no significant difference in hospital arrival time with respect to age, gender, educational level, socioeconomic class, or past history of heart disease (2,4,8-13). A documented medical history of hypertension, diabetes, or angina (4,8,9,12,13), self-treatment of symptoms (2,9,12), and the presence of family members who participated in seeking health care (4,8) all contributed to increased delay time. Chest pain did not shorten delay time unless the patient was unstable (12). These characteristics specific to the cardiac population have been examined to uncover any similarities or trends in the stroke population.

Delay Pattern of Stroke Patients

Despite the severity and prevalence of the disease, little is known about how individuals decide to seek medical help when signs and symptoms of stroke appear. We do know that there are barriers that explain the long delay in seeking care in the stroke population.

The first barrier is the inability to recognize the symptoms of stroke. Often the symptoms are not identified as stroke but as another less serious problem. Stroke victims or bystanders may decide to take care of the problem on their own and delay seeking medical care. In a phone survey conducted by the Dupont Company in 1989, the majority of individuals interviewed did not understand what a stroke was or how to recognize the signs and symptoms (14). In 1996, a Gallup poll conducted by the National Stroke Association revealed that the level of knowledge of stroke symptoms and risk factors has improved since the 1989 poll. However, the improvement was minimal. Face, arm, and leg weakness on one side of the body was the most frequently (58%) reported known symptom of stroke (15). Stroke recognition remains a significant problem when 42% of the population cannot name the most common and recognizable symptom of stroke.

A stroke can impair cognition and judgment and limit mobility, speech, or vision, preventing one's ability to seek help. Stroke may occur during sleep, in which case the onset time cannot be determined and acute intervention cannot be safely implemented.

A number of studies (16-22) have been published on delay time in the stroke population. These studies varied in methodology and had small sample sizes. Moreover, those studies completed in Europe are difficult to apply to the U.S. population because of differences in the health care delivery system. The Duke/Veterans Administration stroke registry (21) revealed that only 42% of a total of 457 stroke patients presented within 24 hours and 33% presented within 24 to 48 hours following the onset of symptoms. The delay time was greatly reduced after initiating changes in the health care delivery system and increasing awareness among both the public and health care providers. Presently, we do not have sufficient data on the delay time for stroke patients. These data are necessary to measure the impact of education and changes in the health care system on delay time for stroke treatment.

A complete understanding of the causes of delay time for stroke treatment will require studies with a large number of patients. Variables that may need to be examined are:

1. Actual presenting symptoms of stroke.
2. Patient and bystander perception of the severity of different symptoms.
3. Circumstances at the time of stroke (onset during sleep, bystander present, location at home or elsewhere).
4. Patient and bystander recognition that symptoms are due to stroke, that they represent a serious problem, and that there is a potential treatment of known benefit.

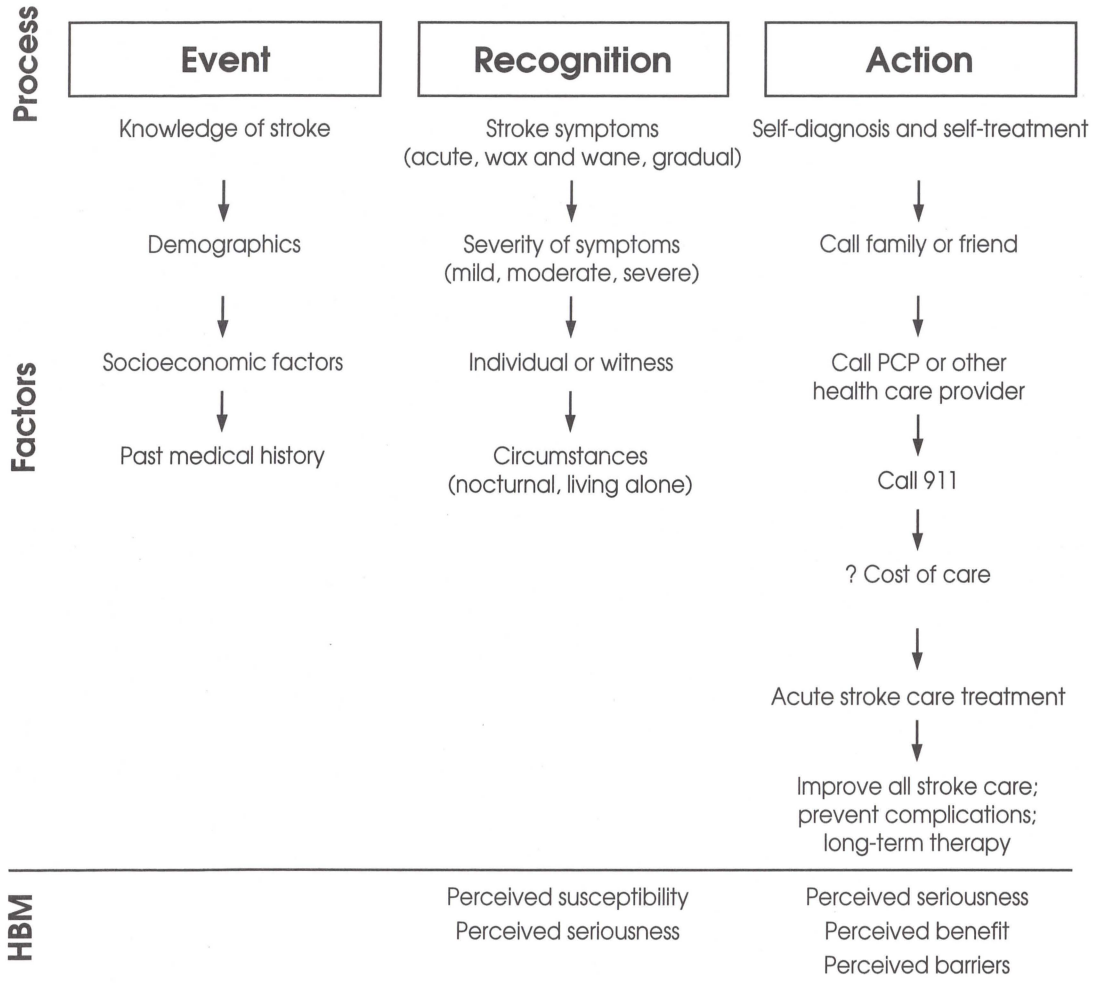
These variables need to be explored further to develop a better model of health-seeking behaviors in acute stroke patients (Figure 2).

Education Campaigns

Because of the devastating results of delaying immediate medical attention, many experts encourage the development of community educational programs to expedite arrival time at the hospital following stroke or heart attack (4,8-11,13,18,20-26). A study by Podell (27) showed that despite educational efforts the number of cardiac patients who did not seek medical attention within 4 hours of the start of symptoms of heart attack in 1976-77 had not changed in comparison to a 1965-66 group.

A community heart disease awareness program was developed, implemented, and measured by Ho et al (28). The entire educational campaign cost $300,000. Cardiac patients who came to the ED with complaints of pain were examined. This specific group of patients was tested prior to and following the education campaign. Results indicated that delays in arriving at the hospital following onset of symptoms did not change, but the level of education increased. Ho et

Figure 2. Health-seeking behaviors in stroke patients: decision-making dilemma.

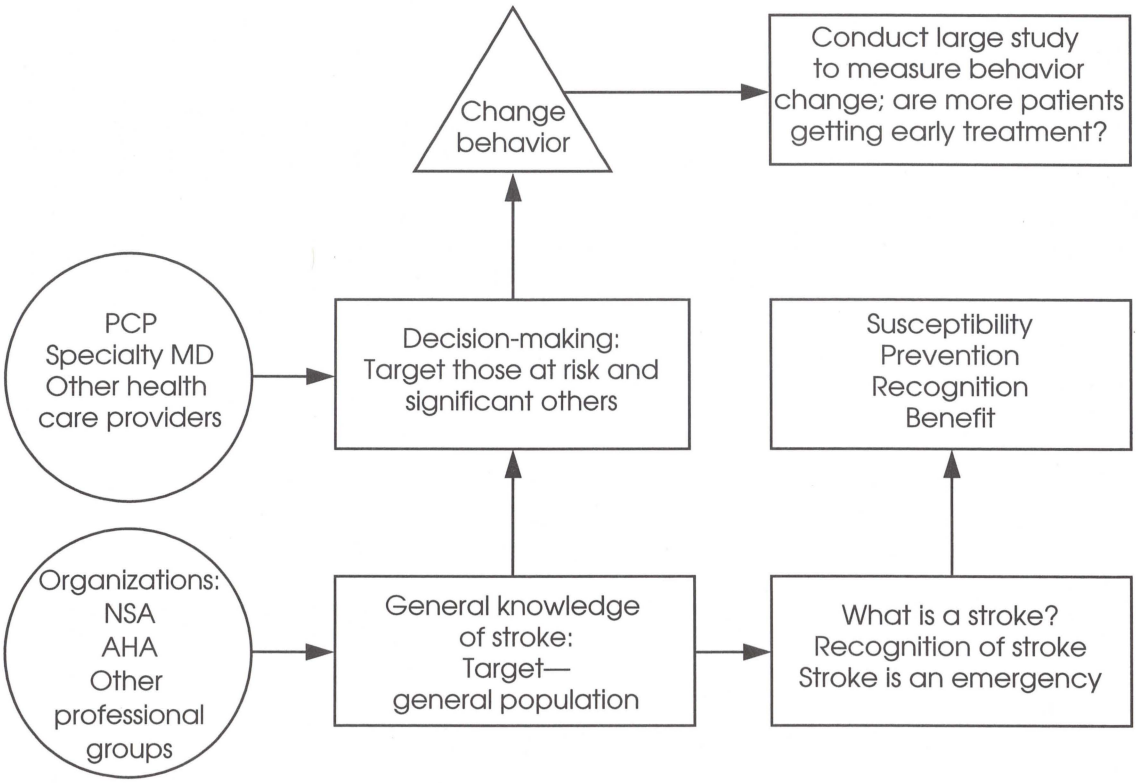


al concluded that education increased the level of knowledge but did not change patient behavior. Years of educational efforts and community awareness programs supported by the American Heart Association did not significantly reduce the delay time of individuals with heart disease seeking medical attention (27). For public education campaigns the most difficult problem is finding ways to effectively change behavior to decrease delay time.

The Proposed Education Process

The proposed education process presented in Figure 3 is based upon what is known about the stroke population, work previously done with the cardiac population, and the HBM. There are two tiers to the process. The first tier seeks to educate the general public; the goals are to increase awareness of stroke, improve the recognition of stroke symptoms, and reinforce

Figure 3. Public education model: decreasing delay time in the stroke population.



the concept that a stroke is an emergency. This effort should be conducted by all those working in the area of stroke, including professional, governmental, and commercial organizations. The second tier of education would focus on those at risk for stroke and their families. These individuals must understand their susceptibility to stroke, their ability to take preventive measures, their need to recognize the symptoms of stroke, and their need to seek immediate medical attention if they have a stroke. Primary care physicians, specialty physicians, and other health care providers need to provide information to stroke-prone individuals in a one-on-one setting.

Whether this process changes behavior is not known. Data should be collected on patients presenting within 6 hours to determine if public education efforts are beneficial. Based on what is already known, the initial reduction in delay time may be the result of health care system changes and increased awareness of the importance of rapid identification and treatment of stroke within the medical community rather than changes in the behavior of stroke patients and bystanders due to public education campaigns.

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How Do We Get From Here to There? The Message, the Audience, and the Medium

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Advertising plays a strong role in the marketing of many products—coffee, cosmetics, peanut butter, toothpaste. It creates and maintains awareness of these products and continually communicates and reinforces an understanding of the benefits the manufacturers promise and deliver. Familiar statements about these products are focused, memorable, and capable of visualization in the medium of television:

Pampers—*For drier, happier babies*

Choosy moms choose ***Jif***

If it's gotta be clean it's gotta be ***Tide***

Pantene—*For hair so healthy it shines*

Bounty—*The quicker picker upper*

The success of product campaigns is by no means assured by vast expenditures of money. The world of communications is littered with advertising campaigns that do *not* work (in the sense of creating behavior change) despite flashy and expensive execution. While it is natural to think about advertising in terms of execution—the film effects, the personalities, the drama, the music—it is the *quality of strategic thinking* preceding the executional work that plays the fundamental role in the ultimate success of an advertising campaign. For example, the underlying factor in the success of the Folgers coffee campaign was the importance that the phrase "the first cup of coffee in the morning" had for coffee drinkers. That piece of consumer understanding and insight *preceded* (and guided) creative work that eventually produced the highly memorable campaign "the best part of wakin' up is Folgers in your cup."

Many people are surprised to learn about the scope and quality of consumer research and analysis that forms the basis for creative advertising efforts. Summarized simply:

Strategy Precedes Execution

The following example demonstrates the "translation" process from strategy to execution. Let us assume for a moment that after reviewing the research on acute stroke and applying our best judgment, we agree that the following represents the most focused expression of the *message content* we want to communicate:

Upon first experiencing stroke symptoms (or observing them in others), I can save life or serious disability by getting to a hospital for treatment very quickly.

This is the "business-speak" of strategy. We are not attempting to be creative but rather to focus on *message content*. Translating business-speak into the language of advertising might produce a mantra such as:

When stroke strikes don't delay—call 911 right away

This is a slogan or summary line. Note that it is unlikely that such a summary line could carry all the information required. For example, calling out specific stroke symptoms would be a necessary part of the total message in a 30-second commercial but would not fit into a summary message.

The point is that the better the strategic thinking, the more likely it is that the advertising messages created for television, print, radio, or the World Wide Web will gain awareness and promote behavioral change. This basic strategic work involves conducting and analyzing research on target consumers to help us understand present attitudes, habits and practices, satisfactions and dissatisfactions, expectations, the hierarchy of benefits desired (both tangible and emotional), and any other relevant information that will give us true insights into the way people think and act with respect to the product or service offered.

This kind of strategic information is finally expressed in summary form in a document generally referred to as a "creative brief." These are the kinds of headings used in such a document (which varies from organization to organization but revolves around essentially the same subject matter):

Creative Brief

- Target audience
- Desired action
- Current consumer beliefs, understanding, and barriers
- Copy strategy
  - Major benefit
  - Reason to believe
  - Brand character

With the acquisition of this information it is possible to move confidently into the *executional* phase where writers, producers, film makers, and art directors translate the business-speak of the creative brief into actual advertising—the television commercial or print ad. Ideally, additional research is conducted during the creative development phase to assure that our executions are understood by and motivating to the target audience.

I have been very impressed with the empirical information gathered to date on issues such as public perception of stroke warning signs, the reasons for delay in seeking treatment, and reports of public and professional educational programs aimed at populations at risk for stroke and myocardial infarction. This says to me that we have a head start on the information required to write a useful creative brief. It is very important that our new initiative respects and learns from the experiences of previous communications efforts with regard to both stroke and myocardial infarction. We must build on the pioneering work of others.

Tempering this optimism is the need for patience in any effort attempting to effect behavioral change in large population groups. Changes that can be measured are often the result of consistent efforts over many years; good examples include the positive results of massive campaigns aimed at modifying nutritional habits, sexual practices, and substance abuse.

To move ahead on a deliberate basis, these are the steps that are required:

Appointment of a core client group. This should be a relatively small number of individuals, representing the appropriate mix of involved organizations. This group is invested with the power to make decisions on behalf of the coalition.

The appointment of a volunteer advertising agency charged with working with the core client group on the creative brief and the subsequent creation of actual executions for the appropriate media. Either as part of the advertising agency commitment or as a separate effort it is important that this initiative have professional public relations input. In the early stages of the emergency stroke treatment campaign it is likely that this kind of information will be welcomed by journalists and radio and TV commentators.

Another critical function of the core client group and the advertising agency is coordination with other constituencies and organizations that will participate in the total emergency stroke treatment initiative. Maximum impact will result from an integrated effort—a total marketing and educational program that creates synergy and an awareness of the message and the product. One of the key objectives of this monograph is to create the resolve, the infrastructure, and the vision to allow this integration to happen.

Funding

Even if the strategy and executional work we produce is of the highest quality it will have no effect unless we can deliver the messages consistently and at high enough levels to our intended audiences. The hard fact is that it is never easy for nonprofit initiatives to secure a ready source of funds for advertising and promotion. For many national public service efforts, organizations like the Advertising Council have been key facilitators in acquiring volunteer services from both advertising agencies and the media. Long-term efforts on behalf of the American Red Cross and prevention campaigns targeting child abuse, crime, forest fires, and drug abuse are ones with which we are all familiar. The Advertising Council has a long list of worthy groups seeking their cooperation, and the emergency stroke treatment campaign needs to be among these groups. However, there are other constituencies that will benefit from successful emergency stroke treatment efforts—pharmaceutical companies, private industry, managed care organizations, and governmental units all have a stake in the success of these efforts. And all of these constituencies are potential sources of funding and resources. All must be approached to create recognition of their enlightened self-interest for supporting the emergency stroke treatment campaign.

Beyond the use of the media there is clearly a continuing role for innovative patient education materials. It is realistic to hypothesize that long after the initial surge of media support for even the best emergency stroke treatment advertising we will need to rely on innovative educational materials directed at the at-risk population, caregivers, and family members. These materials require the same application of focused thinking and creative and innovative execution. For many at-risk people the ready availability of stroke-related information in the home, in the wallet or pocketbook, or on the refrigerator door may be the key to promoting appropriate action and saving lives.

In summary, what I have attempted to describe is the basic process by which advertising and promotion campaigns are developed on behalf of both commercial and public service efforts. Given the potential of the emergency stroke treatment campaign to save lives and improve the quality of life, I'm confident that talented professionals can be recruited, enthusiasm maintained, and resources enlisted to achieve our goals.

Recommendations

Recommendations:

Prehospital Emergency Medical Care Systems Panel

The Prehospital Emergency Medical Care Systems Panel addressed the early needs of the stroke patient in the prehospital setting. The panel, consisting of invited acknowledged specialists in emergency medical services (EMS) systems, took commentary from invited organizations and audience members at large. The assimilated summary recommendations are as follows:

Overall Recommendations

1. Stroke management should be re-prioritized in EMS systems as a time-dependent, urgent medical emergency, just as is currently stressed for major trauma and acute myocardial infarction.

2. A *Chain of Recovery* (Figure 1) should be ensured in each community and emphasized with educational initiatives in order to optimize the chances of recovery for stroke patients.

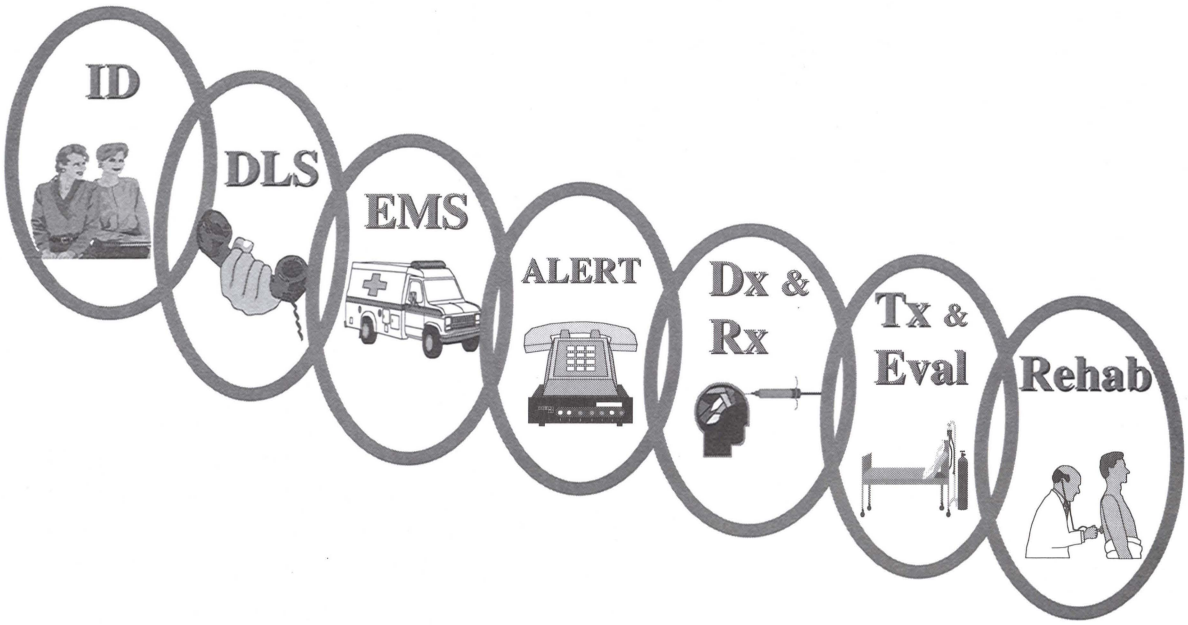
3. New educational initiatives should be developed and widely promulgated, as applicable, for each of the various persons constituting the respective links in the *Chain of Recovery:* (a) the public at large; (b) EMS dispatchers; (c) first-responder crews; (d) basic and advanced life-support ambulance/response crews; and (e) receiving facility personnel, including emergency department (ED) staff members and neurological disease specialists.

4. Task forces should be created to: (a) help develop model educational initiatives for each of the respective links; and (b) develop standardized data sets to help ensure more effective research and outcomes analyses.

Specific Subpanel Recommendations

Three subpanels were organized to specifically address issues related to: (a) EMS dispatch activities; (b) procedures and medical care that should be performed on the scene and en route to the hospital;

Figure 1. The *Chain of Recovery* for acute ischemic stroke patients.



and (c) special considerations in terms of access to care. The specific subpanel recommendations are detailed in separate sections, but can be summarized as follows:

Dispatch Issues

1. The public at large should be educated about how to "make the right call."
2. Enhanced 911 systems (that automatically display the caller's address and telephone number) are strongly encouraged.
3. Dispatchers and dispatching systems should have medical (as well as administrative) supervision that provides medical oversight and continuing medical education.
4. New educational initiatives for dispatchers should emphasize stroke as a time-dependent, urgent medical emergency.
5. Even with the emphasis on re-prioritizing stroke patients, dispatch protocols should still consider sending the closest available transport unit, basic or advanced, in tiered ambulance systems.

6. Additional information should be elicited from the callers regarding relevant medical conditions (such as history of diabetes and current medications) and, also, certain basic medical care instructions should be provided prior to arrival of the EMS crews (i.e., "prearrival instructions").

7. Like all other rescuers in the *Chain of Recovery,* dispatchers should receive feedback and additional reinforcement regarding their actions in stroke cases.

8. Policies regarding stroke patients should be re-evaluated by managed care organizations to ensure that stroke patients receive timely and appropriate care.

Prehospital Medical Care Issues

1. It should be recognized that most texts currently utilized by EMS personnel are lacking in terms of stroke management.

2. Simple, directed assessments should be emphasized in training of EMS personnel regarding stroke management.

3. Except for patients with respiratory distress or insufficiency, low-flow oxygen (1-2 liters/minute) should be administered and, if the tools are readily available, serum glucose levels should be measured.

4. Respiratory efforts and airway patency should be continuously monitored.

5. Although intravenous catheter placement and 12-lead electrocardiographic tracings are preferable, performing these procedures in the prehospital setting should not significantly delay transport to definitive care facilities. Therefore their performance may be venue-dependent (e.g., there is more help available in the prehospital setting than in the ED).

6. In general, hypertension should not be treated in the prehospital setting; hypotension should be treated aggressively (in accordance with the underlying etiology for the hypotension).

7. More data on neuroprotective agents are needed and future prehospital research is recommended.

8. EMS personnel should gather applicable onset information, including telephone access to witnesses/bystanders, and they should collect and/or document *all* medications (particularly aspirin, warfarin, insulin, and antihypertensives).

9. Systems for prealerting receiving facilities should be established so that ED staff members, imaging technicians, and stroke specialists can be readied for the arriving stroke patient.

10. As in the case of dispatchers, EMS crews should receive more feedback and training opportunities that emphasize the urgency of both stroke and transient ischemic attacks (TIAs).

Special Considerations in Access to Care

1. In those venues with multiple medical facilities, it is advised to bypass those facilities not capable of providing appropriate care for the stroke patient.

2. In those venues without nearby definitive stroke care capabilities, it is advised, in general, that EMS providers immediately transport patients to the closest appropriate emergency facility where rapid evaluation and transfer (if appropriate) can be performed.

3. In remote areas without nearby facilities, direct on-scene rescue by air medical services can be considered if: (a) the closest emergency facility is more than an hour away; (b) the closest facility is not capable of providing definitive diagnosis and care; and (c) the patient can reach the definitive care facility within the agreed upon therapeutic time window for stroke.

Research Recommendations

Several recurring questions were asked during the panel sessions. These questions include the following potential research issues:

1. What are the sensitivities and specificities of various dispatch triage algorithms for stroke patients, particularly those evaluating "hot" and "cold" responses or advanced versus basic life-support ambulance dispatches in tiered systems?

2. What are optimal inspired oxygen fractions for stroke patients?

3. Are 12-lead electrocardiographs or glucose measurements of discernible value in *any* given stroke patient?

4. Is the prehospital administration of any neuroprotective agent of value?

5. Are designated stroke centers demonstrably efficacious in altering outcome?

6. What is the safety of air medical transport *after* treatment (e.g., thrombolytic therapy for stroke)?

Conclusions

The Prehospital Emergency Medical Care Systems Panel delineated a roadmap for improving stroke management through an intensive and well-represented consensus process. It is anticipated that this plan will need further refinements, but, for now, the document provides a significant advance in terms of the educational awareness needs as well as a global strategy for improving the *Chain of Recovery* for stroke patients.

Recommendations: Emergency Department Panel

The Emergency Department Panel made specific recommendations in four areas: educational needs for physicians and nurses, response systems, medical management of blood pressure, and classification systems for stroke patients.

Educational Needs

Pathophysiology of Stroke

A thorough understanding of the pathophysiology of stroke is critically important, not only for emergency physicians (EPs) but also for emergency department (ED) nurses. A subject not currently stressed in emergency medicine residency curricula is the natural history of ischemic stroke, and particularly those issues dealing with time-sensitive events in brain ischemia. These include time-critical pathophysiological changes and those events that necessitate an emergency response and early intervention.

Patient identification is a second area that requires more study and better guidelines. Just as emergency medical services personnel must be able to rapidly assess a stroke patient, so too must ED personnel be trained to rapidly appraise stroke-related events. Information that might seem simple to obtain may not be so. For example, establishing the pivotal time of stroke onset can be very difficult.

A third issue regards thrombolysis. Since this is the current treatment for acute ischemic stroke, ED nurses and EPs must clearly understand the inclusion and exclusion criteria for thrombolysis and the potential benefits. The EP may be responsible for explaining risks and benefits to patients and will require a full understanding of the potential complications and risks from such treatment.

One approach to creating effective educational programs on stroke thrombolysis is to teach medical personnel the similarities and differences between coronary and stroke thrombolysis. EPs and nurses have a good understanding of coronary thrombolysis and this knowledge base can help create a similar level of understanding of the unique aspects of stroke and particularly the response of stroke patients to thrombolytic treatment.

Another educational need is training of physicians in the interpretation of brain CT scans. Such training must cover not only recognition of intracranial hemorrhage but also recognition of brain infarction, a sign that may give further information about the time of stroke onset.

Another key subject is blood pressure management, particularly the expected outcome and complications of treating elevated blood pressure. It is important to know how to respond to elevations in blood pressure in all types of stroke. To do this effectively, we need to identify acceptable control measures and appropriate drugs for each stroke type.

Emergency Procedures

Accurate classification of stroke type and quantification of the extent of neurological deficit requires an efficient neurological exam. Unfortunately, neither neurology residents nor emergency residents or nurses are consistently educated in the use of scales like the NIH Stroke Scale. EPs must be able to evaluate stroke patients using the NIH Stroke Scale in order to give quantifiable information to other members of the stroke team. As we go about developing simplified stroke scales for use in the prehospital phase of patient screening, we may also be able to develop more efficient neurological exams for use in triage of stroke patients.

Nurses and physicians will need to be very familiar with communications protocols and will need to understand which protocol to follow when a stroke occurs. A ready method of initiating a stroke team response must be in place.

In a Level I trauma system, effective communications protocols require a great deal of education. Staff in a Level I trauma center know what responses are expected for each type of trauma patient. We need similar types of communications protocols for managing patients with ischemic stroke.

Defining the role of the stroke team is critically important. When does the stroke team need to be involved? Who is on the stroke team? What are the essential tests and standard orders in the ED? What other tests may be needed to make a decision to treat specific conditions that occur in some stroke patients? The answers to these questions may be different for various medical centers but all EPs will need to be educated and involved in the plan that is established.

In addition to a CT scan, what are the essential tests for a patient with stroke? In line with the American Heart Association guidelines, the Emergency Department Panel identified the following necessary tests: complete blood cell count with differential and platelet count; electrolytes, BUN,

creatinine, coagulation profile; chest radiograph; and electrocardiogram. It is critical that certain of these tests be obtained in a timely manner. It will be important to teach the medical staff which tests are essential and which are needed prior to considering specific treatments.

Frequency of Stroke

How frequently does a given hospital admit a stroke victim who is eligible for thrombolytic treatment? Of the 500,000 strokes that occur each year in the United States, about 400,000 will be ischemic. In contrast, each year about 1.5 million Americans have a myocardial infarction (MI). If one assumes that the percentage of stroke patients eligible for treatment is the same as the percentage of MI patients eligible for treatment, this would mean that there would be only one eligible stroke victim for every 3.75 eligible MI patients. Currently, we treat approximately 25% of MI patients but only 3-5% of stroke patients. This indicates that we have a great need to maintain staff awareness with frequent refresher courses. Many physicians lack extensive experience in the area of stroke management. Ensuring quality of care for a disease entity that does not occur frequently will require extensive efforts to maintain adequate levels of awareness and to make allowances for limited experience.

There needs to be a practiced management response to stroke. This can be accomplished through repetitive exercises. We may want to consider stroke team drills similar to mock codes currently used in many hospitals. These drills should review the criteria for proper patient identification, the required tests and procedures to be taken, and the preferred communications systems.

Accentuating the Positive

A key to successful training of medical staff will be to accentuate the positive; this could include case conferences highlighting successful cases, reminders of team goals, and a continuing reminder and feedback system that uses posters. For practicing team doctors and nurses there should be continuing medical education conferences, practice guidelines, and case conferences on a regular basis. For physicians and nurses in training we need to have early involvement of teaching institutions, and we must develop appropriate curricula and reevaluate curriculum design on a continuing basis.

In summary, we must shift attitudes using persuasive evidence of need, establish interdisciplinary working teams, and educate staff about patient selection, effective communication, and coordination of services. We need to teach staff how to clearly differentiate the different types of stroke patients and how to choose the correct treatment for a particular patient. We need different approaches for practicing physicians, nurses, students, and residents in training. And we must accentuate the positive outcomes that can be obtained from early stroke treatment. The emergency management of all types of stroke will be improved by the establishment of timely and knowledgeable approaches to acute stroke management from prehospital through the ED and inhospital phases.

Response Systems

An effective hospital stroke response system should be efficient, high-quality, and cost effective. Some key factors in establishing an effective system include stressing the need for early recognition of eligible patients, early consideration for stroke team activation, and establishing standing orders for patients with stroke.

Certain standing orders that should be utilized relate to serial vital sign monitoring, O_2 saturation monitoring, and rapid glucose assessment. Highly recommended are neurological monitoring with a scale similar to the NIH Stroke Scale and constant cardiac monitoring for all stroke patients. Intravenous access should be established for all stroke patients.

The Emergency Department Panel reached consensus on time-frames that need to be established as goals for those responding to acute stroke:

- A physician should evaluate a stroke patient within 10 minutes of arrival at the ED doors.
- A physician with expertise in the management of stroke should be available or notified within 15 minutes of patient arrival. Depending on the protocol established this may be accomplished by activating a stroke team.
- A CT scan of the head should begin within 25 minutes of arrival. The CT interpretation should be obtained within 45 minutes of arrival. This gives adequate time to perform the scan, process the images, and interpret the results.
- For ischemic stroke, treatment should be initiated within 60 minutes. There was clear consensus on this door-to-treatment guideline among participants in both the Emergency Department Panel and the Acute Hospital Care Panel.
- The time from patient arrival at the ED to placement in a monitored bed should not exceed 3 hours.

Medical Management of Blood Pressure

Medical staff should assess for and appropriately treat hyperglycemia, hypoxia, fever, and congestive heart failure or arrhythmias. But one of the most important components of medical management involves blood pressure control.

There is no evidence from randomized clinical trials to mandate the best method for blood pressure treatment or what levels of blood pressure should be treated for any type of stroke. However, reasonable recommendations issued by the American Heart Association and others can be applied. In general, physicians should avoid treatment if possible and any treatment given should be based on multiple measurements taken 10 to 20 minutes apart and never on a single blood pressure reading.

Patients who present with a sustained diastolic blood pressure greater than 140 mm Hg should receive intravenous infusions of antihypertensive agents. Patients with a systolic blood pressure greater

than 220 mm Hg or a diastolic blood pressure between 120 and 140 mm Hg should receive labetalol or other agents that do not require constant intravenous infusion.

Ischemic stroke patients with a systolic blood pressure less than 185 mm Hg and a diastolic blood pressure less than 120 mm Hg usually do not require treatment unless thrombolytic therapy is being administered. A specific protocol is currently recommended for patients who have ischemic stroke and are candidates for or are receiving thrombolytic therapy. For t-PA, if aggressive treatment is required to lower a patient's blood pressure to meet the requirements for thrombolytic treatment, the patient is not eligible for treatment with t-PA. For example, a patient who requires continuous intravenous infusion of antihypertensive agents to maintain blood pressure below the 185/110 mm Hg level should not be considered a candidate for t-PA treatment.

For intravenous treatment of high blood pressure in acute ischemic stroke patients, the suggested agents include nitroprusside, esmolol, and nitroglycerin. Other agents for intermittent treatment are enalapril or labetalol.

Patients with acute ischemia who present with hypotension, either relative hypotension in a chronically hypertensive patient or hypotension in a normotensive patient, should be treated aggressively to increase the blood pressure.

Classification System for Stroke Patients

Patients should be rapidly evaluated to identify those who require resuscitation for life-threatening situations, treatment for stroke or nonstroke emergencies, or administration of thrombolytic agents. Ideally, patients should be classified at the site where they are first identified. This may be in the ED if the patient arrives as an ambulatory patient, at a referring hospital if the patient is going to be transferred to a stroke center or another facility, or in the prehospital setting where the patient is initially identified.

As is the case for trauma victims, the initial classification of stroke victims should be very simple so that it can be accomplished by a variety of personnel, not necessarily a physician. These include prehospital providers, triage or bedside nurses, EPs, or other individuals competent to apply the categorization criteria. In this first phase of categorization the goal is to cull as many potential patients as possible. While the initial phase of classification is simple to make it applicable to more who are not physicians, the subsequent phases get increasingly complex and specific in order to pare down to those who should receive emergency treatment. Each phase is carried out by increasingly prepared individuals, particularly physicians with stroke treatment experience. For now, at this early point in the development of acute stroke care, providers should be oriented to provide appropriate ischemic stroke patients with thrombolytic therapy since this is the treatment available. Patients who are identified with subarachnoid

hemorrhage or intracerebral hemorrhage should be put through the same rapid categorization for treatment. When it is determined that a patient has a subarachnoid hemorrhage or an intracerebral hemorrhage and therefore is not a candidate for thrombolytic therapy, he or she should then receive treatment appropriate for that type of stroke.

What steps are recommended for categorizing stroke patients?

Step 1 is to identify any life threat. The first part of patient evaluation is always the ABC's—airway, breathing, and circulation.

Step 2 is to identify all potential stroke patients using an abbreviated stroke scale developed for the prehospital and triage phase.

Step 3 is to initiate a priority response by a designated physician to plan evaluation for the use of appropriate emergency stroke therapies.

Step 4 is to complete patient assessment by performing a CT scan and other requested laboratory tests.

Step 5 is to review the CT and laboratory studies, confirm initial estimates of the time from symptom onset, and, if appropriate, administer the treatment.

Recommendations:

Acute Hospital Care Panel

The Acute Hospital Care Panel identified three major issues that are most important for designing acute stroke treatment programs on a national level. These are (a) the proper design and use of stroke critical pathways, (b) the appropriate distribution of medical resources, and (c) the development of medical expertise needed in acute stroke management. Each of these topics is discussed fully in the Acute Hospital Care section of this monograph.

Panel Recommendations

1. Every hospital that cares for patients with acute stroke needs a Stroke Plan.
2. The Stroke Plan should cover stroke care from prehospital recognition through discharge and should address secondary prevention issues.
3. Hospital Stroke Plans should use evidence-based guidelines to develop algorithms and critical pathways appropriate for each institution.
4. Hospital Stroke Plans should include outcomes assessment and be linked with quality improvement.
5. Assuming the patient meets the treatment criteria, the following acute stroke management goals are endorsed:
   - Time from door to doctor: 10 minutes
   - Time from door to CT scan: 25 minutes
   - Time from door to CT reading: 45 minutes
   - Time from door to drug: 60 minutes (80% success target)
   - Time from door to monitored bed: 3 hours
6. There should be access to stroke expertise within 15 minutes of patient arrival at the hospital and neurosurgical expertise within 2 hours of patient arrival at the hospital.

7. The feasibility of establishing a national stroke outcomes database should be explored.

8. Criteria for distinguishing primary, intermediate, and comprehensive stroke centers should be established.

9. A voluntary system for recognizing primary, intermediate, and comprehensive stroke centers is endorsed.

10. The creation of local and regional stroke networks encompassing all levels of stroke care is endorsed.

11. Residency and other health professional training programs should develop educational standards related to acute stroke.

12. Specialty-specific continuing medical education related to acute stroke is endorsed.

13. A Stroke Toolbox containing evidence-based guidelines, algorithms, critical pathways, NIH Stroke Scale training tapes, and other stroke templates should be created, updated, and made easily available through the National Institute of Neurological Disorders and Stroke.

14. The implementation of recommendations regarding stroke centers, stroke expertise, stroke education, and stroke outcomes analysis will require a substantial continuing commitment from the National Institutes of Health and other national organizations.

Recommendations:

Health Care Systems Panel

Significant changes and improvements in our health care system are necessary and are being demanded by patients and payors. Most recently, because of the rapidly changing world of stroke treatment, stroke care specialists are also demanding change. Stroke spans the continuum of health care and we believe it is an ideal illness to guide us through the transition to an improved health care delivery system in the United States.

The Health Care Systems Panel recommends a three-step model for a stroke care delivery system. In the first step we would develop the individual parts of the system; most of this is covered in the reports from the panels on Prehospital Emergency Medical Care Systems, Emergency Department, and Acute Hospital Care. The second step is to develop connections across the various parts of the system so that they work together. And the third step is to institute processes that make all elements of the system work smoothly and effectively.

To make this system work we must develop outcomes assessments that measure clinical quality, functional status, patient satisfaction, and cost. The panel participants agree that our goal is to maximize performance and quality of care, not ownership of the process by any particular specialty or group.

Developing Leadership and Systems Analysis

The first step in creating an efficient system is to identify committed leaders who will act as champions. These people should come from each specialty that has an interest in stroke care. Examples include nursing, emergency medical services (EMS) physicians, emergency department (ED) physicians, neurologists, intensive care specialists, and rehabilitation specialists.

These champions will need not only institutional support, but also training in specific skills, including communications skills to become effective speakers, advocates, and teachers, and also to become good listeners who have the ability to understand the reality of the current health care environment.

To facilitate systems analysis, champions should use flow-charting techniques that will help them understand the nature of the individual components, decide on required modifications to the system, and implement these modifications to create the capacity to care for stroke patients.

Furthermore, these systems should be analyzed from the patient's point of view but should be built from the user's point of view, starting from the inside of the hospital and moving outward from the intensive care units to the EDs to the EMS systems and then to the patients and primary care providers.

Every hospital environment is a bit different and these unique environments will require special solutions and methodologies. The common goal for all, however, will be to deliver high-quality stroke care. As leaders in individual systems apply flow-charting techniques, they should also try to identify key personnel for the stroke teams. They will need to build larger multidisciplinary stroke teams to expand the circle of care. These teams should include all interested specialties, including trainees in these specialties.

Finally, these teams should practice their skills in caring for stroke patients to ensure that their first experiences are positive for both the patients and the care providers.

How to Create and Sustain the Continuum of Acute Stroke Care: Steps That Need to be Taken at the Strategic Level

The Health Care Systems Panel agreed that it is very important to establish consistency of high-quality care as a primary goal and to do it in a way that will not affect the autonomy of local physicians, whatever their specialty. This will mean providing them with resources, education and training, and referral opportunities if they feel they need help with a given patient. Those who activate the acute stroke treatment system should work with the approach that "one call does it all," with everyone on the acute stroke team linked together with pagers or cellular phones. All members of the stroke team should receive regular feedback on their performance based on established criteria for quality care.

Health systems need to be integrated functionally, financially, and legally. Since stroke is a disease of multiple causes, we must focus on disease management regardless of physician specialty. We must break down walls between departments within institutions and health systems so that the focus is on disease management without regard to departmental "territory." We need to create and maintain linkages throughout the system so that patients are followed seamlessly from primary prevention through acute episodes through rehabilitation and subsequent care.

We need to establish a network of regional workshops where medical personnel can receive hands-on skills training in acute stroke care management. It may even be useful to establish certification or special added qualifications requirements for stroke care specialists. This leads to the issue of people-intensive systems versus technology-intensive systems. In the former case, we can accomplish much through national organizations and small group workshops. Technology-intensive systems can make use of telemedicine and telecommunications to help in sustaining the system. This may be an effective way to reach medical personnel in rural sites and underserved urban sites. Telemedicine might help to ensure standardized, streamlined care throughout the nation's hospitals and to centralize medical specialists. Establishment of electronic links to hospitals and physicians capable of providing on-the-spot rapid expertise deserves consideration when expertise is not rapidly available to treat stroke locally. Our ultimate goal would be to build systems that will allow us to treat patients and to accelerate development of new treatments and diagnostic technologies for stroke patients.

Determining Acceptable Outcomes

Determining and measuring acceptable outcomes is a process in its infancy. Although we have made progress in identifying acceptable outcomes in stroke care, we still need to identify who will measure these outcomes and what reliable and valid measurement tools are available. We also need to decide whether to assess small groups of patients, individual institutions, groups of institutions, or regions.

Because the measurement process should be as efficient as possible, we need to agree on a minimum set of key indicators. We believe that the patient's interests must come first, so we need to identify big-impact items and choose indicators for which valid and reliable measurement tools already exist.

We believe that the indicators could follow the chronology of stroke care, and using that as a guide we can make several simple recommendations.

- In the prehospital setting we need to first assess symptom recognition and the use of the 911 system.
- In the emergency department we believe it is most important to assess time to evaluation and to treatment.
- In the hospital setting it is important to assess whether detailed and comprehensive stroke protocols are in place.
- After discharge we need to assess the patient's functional capabilities and assure that high-quality rehabilitation services are in place.
- Overall, we need to institute comprehensive data collection and feedback. One suggestion is a "report card system" that establishes a sense of accountability for the care of the acute stroke patient. We can all agree that certification of stroke care centers is on the horizon.

What Value do We Add to the System?

Thrombolytic therapy in the form of t-PA is no longer experimental. It is FDA approved and its use should be reimbursable. But other steps in the process necessary to make acute stroke care succeed also need to be funded. Stroke, at least acute episodes of stroke, appears to be a disease that requires a "reverse gatekeeper," a disease where specialists are necessary up front. In order to justify funding for this we need to identify cost savings that will result in a shift of resources to the most critical points in the stroke management continuum. We are encouraged that some success in this area has already been achieved. All available data suggest that when a comprehensive stroke care plan is in place and thrombolytic therapy is used, the length of hospital stay is reduced and outcome is improved.

It is our goal to maximize value by maximizing quality for the lowest cost. It is very important to state, however, that cost savings might not be universal but we need to support such a system because it is right for our patients.

Recommendations:
Public Education Panel

Public education is probably the most important process in the global effort to improve access to treatment for acute stroke and probably the most difficult to achieve. The scope of public education regarding stroke is huge, but our goal is to uncover the specific public health messages that will most effectively produce immediate recognition of stroke and immediate health-seeking behaviors.

Lessons Learned From Previous Successful Public Education Campaigns

Public education works. Examples of successful public education efforts include increasing the use of seat belts, decreasing smoking, and changing dietary habits, especially with respect to low-fat diets.

Change is slow. As we begin to educate patients we can't expect an immediate influx of patients into emergency departments, so we must be persistent and patient.

Big, comprehensive programs are the most effective. We need to use many communication formats, identify different audiences and tailor the message to those audiences, and seek a wide range of sponsors and funding agencies.

Defining our audience as the "general population" is not useful. The general population contains many subgroups, with different backgrounds and different methods of learning. Different messages must be developed for these varied subgroups. In the open discussion following the formal presentations at the symposium it was suggested that we avoid limiting the target audience to the stroke-prone population. Because many patients generally call family members—especially sons and daughters—upon first experiencing symptoms, all age groups should be included in the target audience.

Having an effective message and successfully delivering that message do not guarantee behavior change. Motivation to change behavior occurs when the public perceives that the benefits exceed the cost of the change. Our message must be simple, clear, and repeated often.

We need more sophisticated research on behavior modification and its links to public education programs. Another audience comment concerned the issue of fear. Some stroke patients are fearful of contacting a doctor when experiencing stroke symptoms. The issue of fear, and its motivating factor, needs to be addressed in a research setting. We have already begun to gather some data on behaviors that delay treatment. There are multiple theories we can use to guide us in creating the best message.

What Are the First Steps We Should Take?

We must understand our audience and craft a message that they think is important to act upon. Focus groups are one route to achieving this understanding. We need to understand how and why individuals currently seek health care and what contributes to delay time in seeking care.

There are many different models of health-seeking behaviors that we could use to guide our efforts. The Health Belief Model (HBM) was the one we chose to present to the symposium attendees. This model was selected because it is based on the premise that an individual's unique perception of his or her world determines what actions he or she will take. The basic concepts of the HBM are **seriousness, susceptibility, barriers,** and **benefits**: Individuals must understand the **seriousness** of the health risk, their own personal **susceptibility** to this risk, and the **benefits** of seeking health care if they experience (or witness) symptoms. **Barriers** to achieving the above goals must be identified by scientists; they may include cognitive barriers, physical limitations, or situational factors (for example, when stroke occurs during sleep or the stroke victim lives alone). We must develop ways to intervene when these barriers exist and make the system work despite them.

Audience comments also included the subject of accomplishing public education through initially educating primary care physicians and family practitioners such as internists. These are typically the health professionals first contacted by patients experiencing symptoms. One approach might be to send the most appropriate public education message to professional meetings attended by primary care and family physicians or to place ads in medical journals targeted to primary care physicians.

How Do We Get From Here to There?

If we do all of the above, the result will be an effective approach to public education and the development of a model for producing the best decision-making possible. The Public Education Panel agreed that the Madison Avenue approach to successfully delivering messages is the one we

should follow. In this approach, strategy always precedes execution and the tool we must use is the **creative brief,** a document that defines the target audience, identifies the desired actions to be taken by that audience, presents current consumer beliefs and barriers to taking action, and establishes long-term goals. All of this information will be used to create the best messages, using the best available communications vehicles and delivering these messages in the most effective manner possible.

One audience suggestion concerned the use of TV, in particular TV dramas, to convey our messages about rapid treatment of stroke. The idea was summarized as "Show, don't tell." Presenting dramas that show doctors treating acute stroke patients in emergency situations is likely to be a powerful way to educate the public.

We need to seek help from experienced professionals in advertising to create public service announcements, print ads, and broadcast messages that will deliver our message. Finding money for accomplishing our goals will be a great challenge. We need to approach the groups and organizations that will benefit most from the shift in stroke care. This means pharmaceutical companies, private industry paying benefits for employee disabilities, government agencies, insurance companies, and health maintenance organizations.

We will need a central access point for information—a clearinghouse for both health professionals and the public. One obvious possibility is an Internet site that links the various organizations so that our message will remain consistent.

The panel discussed the timing of our educational efforts. Although some staging in the timing of our educational efforts is desirable, we know that education is a long, continuous process. And it is a parallel process—the health care system will be changing while we are educating the public—so the timing of our programs will change as the systems change.

Finally, to pull together all of these threads, the Public Education Panel strongly recommends developing a core leadership group to lead the effort. We need strong national leadership to move this initiative forward, and our recommendation is that the National Institute of Neurological Disorders and Stroke should take that leadership role.

Final Keynote Address

Final Keynote Address

Final Keynote Address:

Principles of Effective Management of Acute Stroke

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From Shakespearean times and beyond, stroke has aged our youth, destroyed the autumn of our life, and chilled the winter of our discontent. But in more recent times, there has been a major change in the effect stroke has had on our lives and we are hopeful that there will be future changes as well.

Over the last few years we have reached a number of milestones in the management of stroke. The list of milestones begins with the development of arteriography and echocardiography, procedures that were first used in the early 1950s. Another major advance was the identification of risk factors for stroke and the discovery that these risk factors could be manipulated to reduce the incidence and prevalence of stroke.

The introduction of randomized clinical trials by the National Institute of Neurological Disorders and Stroke was a particularly notable step forward. These trials included not only trials for drugs like platelet inhibitors and anticoagulants, but also surgical trials. This was an extraordinary achievement for stroke research and major credit goes to the clinical scientists, particularly the surgeons, who provided the skills to conduct and design these trials. When we look back over the last 15 years at the results and changes brought about by these studies—the NASCET (1), the SPAF trials (2-4), the ACAS (5), and now the NINDS t-PA Stroke Study (6)—we can see just how extraordinary these programs are. They reflect clear planning and a great deal of foresight, and have had a major impact on the health of our society.

We entered another major technological era with the introduction of CT scanning and MRI/MRA, tools that will help us further define the progression of stroke in our patients.

But now we come to a new milestone in stroke management: advances in acute stroke treatment. The spotlight has been on t-PA and indeed this drug did precipitate the need for new strategies in acute stroke management. But our focus during this symposium has been not only on this new drug treatment, but also on how we manage acute stroke and the strategies we can use in the future to manage it more effectively. In addition, we hope that a number of other new brain protective drugs will be available soon and for which we will be prepared because of the new systems we develop as a result of this symposium.

This monograph outlines a number of underlying general principles of effective stroke management. The first is that the interests and needs of patients with stroke and their families should be the primary concern of all stroke care professionals. Progress in acute stroke management will only be achieved if stroke is considered a medical emergency and that means that all stroke patients must receive immediate evaluation at hospitals. Support by self-help and voluntary patient associations must be encouraged to educate the public about the symptoms of stroke so that care providers have the opportunity to deliver this immediate evaluation.

A second principle is that all current and future therapies for stroke should be based on scientific evidence, and treatments of unproved value should not be used routinely in stroke patients. Management of all aspects of disability should be planned in close collaboration with patients and their families. And collaboration in stroke research—including prevention, acute management, nursing care and rehabilitation, and education—should be promoted at local, national, and international levels taking into account the needs and contributions of all professional groups and patient associations.

These principles reflect the same essential principles for good practice that have been outlined by the Europeans in the Helsingborg Declaration of stroke management (7). The European community recently recognized the need for community strategies in the management of acute stroke and put this recognition on record. And now this monograph presents the generalized recommendations for changes in stroke management in the United States. The specific details of how this is carried out should be determined by organizations at the local level, and we recognize that regional implementation will vary widely.

Conclusions from this conference that all participants can agree on are summarized as follows:

Prehospital care: This part of our community is already willing to change and be flexible. In fact, the system needs only minor modifications to achieve the goals we have established of more rapid response to acute stroke. Perhaps more important is to establish that research is needed to continue to make improvements in our prehospital care of patients.

Emergency department care: For stroke, just as for myocardial infarction and trauma, it is essential that emergency departments be reorganized and realigned to work in concert with prehospital care providers and then to move carefully selected patients into acute hospital care departments.

Acute hospital care: This critical link in the management of stroke may be the most challenging in terms of making changes to accommodate the movement toward rapid treatment. But changes can and will occur, as was demonstrated in the NINDS t-PA Stroke Study. That study showed that, with proper management of the systems, we can indeed recruit patients within the 3-hour time-frame. We must work, however, to extend that therapeutic window, perhaps through the use of newer, sophisticated imaging techniques or with enhancement of CT scan diagnostic potential. Questions we should answer include: "Is reperfusion safe?" "Will treatment cause hemorrhage?" "What are the issues we should consider in predicting hemorrhagic conversion, staging of stroke, identifying viable tissue, predicting cell death, and identifying creative ways to extend the therapeutic window?"

Health care systems: We must work to continually improve integrated stroke management delivery systems. It is vital for us to create a system of care that responds appropriately to the needs of our patients while considering also the larger societal need to control costs.

Public education: The final domain is public education, that which is most essential if we are to deliver acute treatment strategies to patients. This is clearly the most difficult challenge—changing the behavior of our patients—and we will need to develop innovative processes to accomplish this goal.

Conclusion

A final observation is that we should set targets for ourselves: these targets should include establishing systems of organized management of acute stroke, providing access to specialized assessment and treatment at stroke centers, providing access to specialty stroke rehabilitation, and providing access to information on stroke prevention. We can never forget the importance of continuous improvements of our systems and quality assessment programs.

What rigorous targets can we set for ourselves? Suggestions include reducing the 1-month death rate to below 20%, reducing the 2-year recurrent fatal and nonfatal stroke rate to below 20%, reducing vascular death overall to less than 40%, and having 70% of our stroke patients engaged in activities of daily living at 3 months after stroke (7).

All of us involved in this effort should move forward with optimism to achieve these targeted goals and make successful management of acute stroke a reality for all communities.

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Appendices

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Agency for Health Care Policy and Research
Air Medical Physician Association
Alliance for Aging Research
American Academy of Emergency Medicine
American Academy of Neurology
American Academy of Nurse Practitioners
American Academy of Physician Assistants
American Association of Critical Care Nurses
American Association of Health Plans
American Association of Neurological Surgeons
American Association of Neuroscience Nurses
American Association of Occupational Health Nurses
American Association of Rehabilitation Nurses
American College of Cardiology
American College of Emergency Physicians
American College of Physicians
American College of Radiology
American Congress of Rehabilitation Medicine
American Geriatrics Society
American Health Care Association
American Heart Association
American Hospital Association
American Medical Association
American Neurological Association
American Nurses Association
American Red Cross
American Society of Interventional and Therapeutic Neuroradiology
American Society of Neuroimaging
American Society of Neuroradiology
Association of Schools of Allied Health Professions
Center for Emergency Medicine
Centers for Disease Control and Prevention
Child Neurology Society*

** Representatives of the Child Neurology Society provided the Symposium organizers with a written statement addressing the special needs of children who experience stroke. This statement will be made available through the "Acute Stroke Toolbox" Internet Web site, being developed as a direct result of this Symposium.*

Commission on Accreditation of Medical Transport Systems
Congress of Neurological Surgeons
Council of Residency Directors
Dana Alliance for Brain Initiatives
Department of Defense, Health Affairs
Department of Veterans Affairs
Emergency Nurses Association
Food and Drug Administration
Health Care Financing Administration
Health Resources and Services Administration
International Association of Fire Fighters
National Academy of Emergency Medical Dispatch
National Association for Health Care Quality
National Association of Emergency Medical Services Educators
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National Center for Health Statistics
National Coalition for Research in Neurological Disorders
National Council of State Emergency Medical Services Training Coordinators
National Flight Nurses Association
National Foundation for Brain Research
National Heart, Lung, and Blood Institute
National Highway Traffic Safety Administration
National Institute of Nursing Research
National Medical Association
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National Stroke Association
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Society for Nuclear Medicine
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Society of Critical Care Medicine
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As scientists and health care providers continue to refine the current treatments for stroke and develop other potential treatments, some of the guidelines presented in this volume may change. The recommendations developed during the Symposium and presented in this volume are intended to help health professionals make more informed decisions concerning the care of their individual patients. As always, those responsible for direct patient care will base their treatment decisions primarily on information they gather from their patients and the circumstances specific to those patients. This volume will assist in making those decisions but is not intended to replace the expertise available only to those in direct contact with stroke victims.

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