Regionalization of Stroke Care: What Can We Learn From Level 1 Trauma Centers?

Rapid triage and transfer of the most critically ill patients to the most skilled physicians is the linchpin to effective regionalization.

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Stroke is the second leading cause of death worldwide after cardiovascular disease.[1] In the United States, the overall cost of stroke is estimated at $73 billion annually, with the cost projected to continue to increase.[2] The tools to treat stroke continue to be developed and improved. There is now overwhelming evidence supporting mechanical thrombectomy for emergent large vessel occlusions (ELVOs), and newer studies such as the DAWN trial continue to validate intervention at increasing time intervals.[3] Complete stroke care includes more than just access to intravenous tissue plasminogen activator (IV tPA) or mechanical thrombectomy; patients often require access to neurointensive care specialists, neurosurgical care, and comprehensive rehabilitative services for poststroke care. Furthermore, there is ample evidence demonstrating stroke outcomes are better at higher-volume centers.[4,5] Unfortunately, not all patients have immediate access to nearby comprehensive stroke centers (CSCs), nor do all stroke patients require transfer to a CSC for their care.

We know that "time is brain" and that higher volume concentrated in select centers is likely to increase the safety and efficacy of mechanical thrombectomy procedures. Therefore, the dilemma is, how do we effectively find balance between these two seemingly opposing goals? One answer to this is the regionalization of stroke care, a concept that has transformed the treatment of trauma patients and could provide a useful blueprint for the advancement of comprehensive stroke care.[6]

REGIONALIZATION OF TRAUMA CARE

Trauma care in the United States was revolutionized in 1966 following the publication of *Accidental Death and Disability: The Neglected Disease of Modern Society* by the National Academy of Sciences.[7] This document publicized the high cost of trauma in the United States, not only in human terms, but also by highlighting the associated economic impact of trauma. Following publication of this document, Congress passed legislation to expand ambulance and helicopter services as well as increase funding of emergency medical services (EMS). In addition, in 1971, the American Medical Association proposed the hierarchical classification of hospitals based on their size and ability to care for trauma patients. This led to the development of many statewide trauma systems and eventually to the Committee on Trauma releasing a statement in 1976 calling for the regionalization of trauma systems.[8]

EFFECTIVE TRIAGE OF THE TRAUMA PATIENT

The essential principle of regionalization as it applies to the modern delivery of trauma care is simple: stabilize and assess the patient rapidly, triage appropriately, and transfer to a higher level of care immediately for definitive management of sustained injuries. The trauma literature affirms these principles; multiple reports demonstrate that patients treated at level 1 trauma centers have better overall functional outcomes with higher clinical volumes associated with better outcomes.[9-12] Fundamental to this success

is the ability to accurately triage patients based on four fundamental factors in a reproducible fashion. The factors considered are physiologic function (eg, Glasgow Coma Scale, blood pressure, respiratory rate), anatomic factors (eg, penetrating injuries, open fractures, paralysis or neurologic deficit), mechanism of injury (eg, extremely high falls, high-speed motor vehicle accident), and individual patient considerations (eg, burns, advanced age, concomitant pregnancy, provider discretion).

This method of organization allows for rapid triage. A patient meeting a high-risk criteria from one of the first two categories should be immediately stabilized and transferred to the highest-level trauma center for definitive management. A patient with only a factor from the third category should be evaluated at a trauma center, but it does not need to be a level 1 trauma center. Patients with one factor from the fourth category could be transferred to another area hospital with trauma expertise, but it is not necessary. A standardized approach like this allows for reproducible, rapid assessment of trauma patients for triage to the most appropriate trauma center quickly.

LEVEL 1 TRAUMA CENTERS AS A BLUEPRINT FOR COMPREHENSIVE STROKE CARE

A recent report estimated that, in the United States, there are 200, 250, and 375 level 1, 2, and 3 trauma centers, respectively.[13] Overall, this equates to a ratio of approximately one level 1 or 2 trauma center per every 600,000 people and results in an estimated 84% of United States citizens living within 1 hour of a level 1 or 2 trauma center by ambulance or helicopter.[13,14] This is an important statistic for the more than 750,000 trauma patients who presented to 744 trauma centers in 2011.[15] Of these patients, 600,000 met the criteria for minor trauma, while more than 150,000 met the criteria for major or polytrauma by their Injury Severity Scores. Thus, each trauma center sees approximately 1,000 victims of major or minor trauma each year. In addition, level 1 and 2 trauma centers averaged 340 victims of major or polytrauma annually.[15]

This system of regionalized care implemented by the American College of Surgeons provides an excellent framework for the future development of stroke triage. Through efficient, standardized metrics for triage applied expediently, trauma patients are triaged to appropriate centers without delaying patient care or diluting volume of trauma centers. These same challenges exist in the treatment of stroke patients, which often involves a race against progression from ischemic penumbra to core infarct, much akin to the golden hour for severely injured polytrauma patients. For instance, patients with clear and significant neurologic deficits would benefit from immediate transfer to a CSC, while other patients with less significant deficits may first be stabilized, triaged, and treated (drip and ship) before transfer to a higher center of care. Other stroke patients with minimal deficits may be appropriately managed at community hospitals. Establishing a system that can capture and stratify patients based on stroke severity and expeditiously triage each patient to an appropriate nearby facility is integral as a public health measure to improve stroke outcomes.

CURRENT STATE OF STROKE CARE REGIONALIZATION

Currently, stroke care is fragmented. Often, the transfer of patients to a given facility is based on emergency medical personnel preferences or hospital affiliations rather than an implemented evidence-based protocol for stroke patients. In many instances, stroke patients are taken to a community hospital where the diagnosis is made in the emergency department. Typically, in this scenario, a tertiary center physician provides advice and initial management points for the treating physician either via telestroke or when contacted for transfer, such as initiation of a IV tPA drip with immediate transfer to the tertiary center for definitive evaluation and management. Approximately one in six patients who are diagnosed with stroke receive their care in a fashion similar to this.[16] Recent experiences with implementing telestroke evaluation into a regional stroke system showed the potential for significant improvements. One such experience in New Zealand led to a 10-minute reduction in door-to-needle time and doubled the rate of tPA administration.[17]

Although this system does result in the transfer of the patient to a higher level of care, it is nonstandardized and problematic, especially due to significant delays that occur during the decision-making and transfer processes. For instance, many patients with severe strokes would benefit from bypassing community hospitals altogether and being taken directly to a CSC. There are now a number of accepted prehospital stroke scales that may aid emergency providers in more effectively triaging patients. For example, the Los Angeles Motor Scale and Cincinnati Prehospital Stroke Scale are short, easy to use, and accurate predictors for acute ELVO.[18] However, these and similar stroke scales are not uniformly used or followed.

STEPS TOWARD ORGANIZED STROKE CARE DELIVERY

With the triage tools developed and the CSCs in place, the largest obstacle in the way of improving stroke care is the coordination of these resources. Efforts across the country and internationally have been initiated with the aim of organizing and regionalizing stroke care in the manner of trauma care. Two notable examples include

the Los Angeles County experiences as well as the IMPROVE stroke care initiative.[19]

Los Angeles County EMS recently changed policy from immediate transfer of a suspected stroke patient to the nearest emergency department to transferring to the nearest approved stroke center. This change resulted in an almost ninefold increase in the proportion of patients cared for at an approved stroke center without a statistically significant increase in time from on-scene to the emergency department.[19] Although the prehospital time was not increased, it has been suggested that a modest increase in this time in exchange for transport to a CSC is a reasonable and likely advantageous change.[6] For a patient with a high likelihood of acute ELVO, the immediate availability of endovascular intervention is key. Interestingly, both the cardiac and stroke intervention literature demonstrate that high-volume centers have consistently lower door-to-intervention times compared with low-volume centers.[20,21]

The IMPROVE stroke care network is a newly established consortium of health systems in the "stroke belt," which includes North and South Carolina, Georgia, and Tennessee, with the goal of improving regionalization of stroke care. Although nascent, the goal of the IMPROVE program is to expand delivery of stroke care by effectively integrating communication of prehospital care providers for appropriate and timely triage within the region. Emphasis will be placed on rates of under- and overtriage as well as direct transport to CSCs when ELVO is suspected. Although these two initiatives are relatively young, they represent initial, concrete steps toward regionalization of stroke care delivery using principles pioneered in the trauma literature.

CONCLUSION

Stroke care in the United States remains suboptimal, with fragmented care delivered inconsistently by physicians with varying degrees of stroke expertise. Although recent efforts have led to improvements in stroke care, orchestration of stroke care remains one of the biggest hurdles in optimizing stroke outcomes. Trauma systems that care for patients in need of rapid triage and delivery of care by highly specialized providers have implemented cohesive regionalization to improve their patients' morbidity and mortality. Along those lines, we encourage the continued regionalization of stroke care, anchored by stroke providers and regulated and promoted by collaboration between the major societies and government. Through this cooperation, well-coordinated CSCs can deliver high-quality care to the population of the United States in an organized, resource-efficient manner. ■

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