Triage for Higher Level of Care

Which is best: primary, comprehensive, or just thrombectomy-ready?

By Nerses Sanossian, MD

Introduction

There have been major advances in prehospital evaluation and triage of patients with stroke symptoms in the past few decades. Progress has been made in educating the public about the importance of activating emergency medical services (EMS) as soon as stroke is suspected, prehospital stroke identification, and routing of patients with stroke to designated acute stroke center hospitals. Areas of active investigation in prehospital stroke include in-ambulance therapy (eg, use of neuroprotective agents), mobile stroke units (MSUs) with imaging capabilities, and multitiered routing protocols. The goal of any prehospital system of stroke care is to deliver patients quickly and safely to the most appropriate hospital.

Prehospital care has had to adapt to recent developments in endovascular care of patients with large-vessel occlusion (LVO) ischemic stroke for whom endovascular thrombectomy with standard stroke care has proven efficacy for reducing disability and improving outcomes.[1-4] In this light, prehospital care systems have had to reevaluate identification, routing, and treatment protocols for patients with potential LVO. This article reviews the current state of prehospital routing for patients with stroke, the landscape of prehospital recognition and triage of with LVO, and future directions for routing patients experiencing a stroke and addresses the question of what is the best system of stroke triage: transport to the closest primary stroke center (PSC), thrombectomy-capable stroke center (TCS), or comprehensive stroke center (CSC).

Current Prehospital Evaluation for Stroke

About half of patients experiencing stroke arrive to the emergency department (ED) by ambulance, putting emergency medical service (EMS) providers in a unique position as the first medical professionals to evaluate a patient with stroke. Recognizing a potential stroke patient begins with EMS dispatch operators who field emergency calls (usually via 911 services in the US).[5] Stroke identification by dispatch operators has low sensitivity and high specificity. This is because not all callers are able to correctly identify symptoms and signs of stroke and relay them on the phone. Dispatcher identification of potential stroke leads to activation of an appropriate EMS team, usually via an advanced life-support ambulance.

Most paramedics and emergency medical technicians (EMTs) are trained to use validated prehospital stroke recognition tools, most commonly the Face Arm Speech Test (FAST)/Cincinnati Prehospital Stroke Scale (CPSS). Other validated screening tools include the Los Angeles Prehospital Stroke Screen (LAPSS), Recognition of Stroke in the Emergency Room (ROSIER), Melbourne Ambulance Stroke Scale (MASS), Ontario Prehospital Stroke Screening tool (OPSS), and Medic Prehospital Assessment for Code Stroke (MedPACS). The CPSS/FAST has 3 components—unilateral facial weakness, unilateral arm weakness, and speech abnormality—and the highest level of sensitivity. More complex instruments such as LAPSS have higher specificity at the cost of lower detection rates.[6] None of the stroke screening instruments is particularly good at picking up posterior circulation symptoms.

When a stroke diagnosis is not made in the field, it can still be made in the ED where the regional stroke system can be accessed. All prehospital stroke-triage protocols incorporate paramedic-determined last known well time (LKWT) and incorporate transport times into their routing algorithms. For example, routing to a stroke center may not be feasible if transport time would be over 1 hour. Regional routing protocols vary widely in characteristics, including screening instrument, symptom onset time, destination facility features, and transport times.[7] Each regional stroke system has to be tailored to local geographic resources.

The practice of routing patients with stroke to a designated hospital rather than the closest hospital has been expanding, leading to meaningful differences in the proportion of patients with stroke who are cared for at certified stroke centers.[8,9] In Los Angeles, implementation of stroke-specific routing increased the proportion of patients with stroke being seen at certified centers from 1 in 10 to more than 9 in 10, with no clinically significant increase in prehospital care time.[10] This expansion of EMS care systems has been in parallel to increased numbers of hospitals seeking stroke center certification nationwide.[11] Currently, more than 1 in 3 acute care hospitals are certified in some manner as a stroke center.[12]

A multitiered stroke center certification was developed as it was recognized that increasing specialization leads to better outcomes in stroke (Table). With so many stroke certification tiers, there is often confusion on how to approach prehospital triage, and this is an ongoing area of research. There is agreement on the importance of rapid transport to minimize delay. Paramedics gather information key to stroke evaluation including LKWT and current medications prior to transport. Vital signs are monitored during transport and there is prenotification to the receiving hospital in most cases. These are outlined in the American Heart Association (AHA)/American Stroke Association (ASA) policies to guide systems of stroke care delivery.[13]

Challenges for Prehospital Care

Identifying and Routing Patients With Large Vessel Occlusion

Identifying patients with LVO in the field is the first step to improving outcomes. The first generation of stroke screening tools was developed for stroke recognition with no focus on LVO. There have since been many attempts to develop a prehospital instrument to identify patients with LVO, including the Los Angeles Motor Scale (LAMS),[14] Prehospital Acute Stroke Severity (PASS) scale,[15] CPSS,[16] and the Rapid Arterial oCclusion Evaluation (RACE) scale.[17] All are designed to be brief and easy to administer by paramedics; none has emerged as a consensus leader. Identification of patients with LVO in the field is intended to help in routing patients past a nonendovascular stroke center (acute stroke ready [ASR] or PSC) to an endovascular-capable center (TCS or CSC) (Table), which creates the opportunity to consider regional routing systems with only 2 tiers (Figure 1).

TABLE. THE 4 TIERS OF STROKE CENTER CERTIFICATION.

Tier	Capability
Acute Stroke Ready Hospital (ASR)	Able to initiate tissue plasminogen activator (tPA) prior to transfer to a higher-level stroke center
Primary Stroke Center (PSC)	Have protocols and specific care pathways for patients with stroke
Thrombectomy-Capable Stroke Center (TSC)	Able to initiate tPA and provide endovascular treatment
Comprehensive Stroke Center (CSC)	Can initiate tPA, provide endovascular surgery, and neurocritical care with stroke-specific protocols and care pathways.

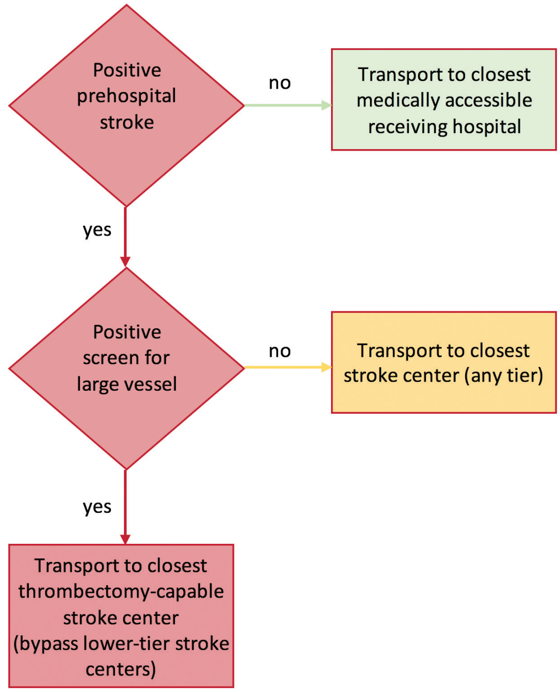

Figure 1. Model for using screening for large vessel occlusion in prehospital care.

The effect of 2-tiered routing and comparison of this method to a single-tiered method is unknown at this time. The RACECAT[a] clinical trial is testing the hypothesis that bypass of the closest stroke center and direct transport to the closest TCS will improve outcomes in paramedic-evaluated patients with stroke.

There are 3 approaches to patients with suspected stroke who are eligible to be treated with tissue plasminogen activator (tPA) (Figure 2). In the first option, which can be thought of as "drip-and-ship," the patient is transported to the closest stroke center, regardless of tier, for earlier intravenous tPA and in-hospital screening for LVO followed by secondary ambulance transport to an endovascular center if that is indicated. In the second approach, the patient is transported directly to a TCS, bypassing closer stroke centers that are not thrombectomy-capable. Although this could delay tPA administration because of a longer transport time, it might shorten overall time to thrombectomy because the patient would be taken directly to a "mothership" with all aspects of stroke care—tPA, thrombectomy, and poststroke critical care—in an all-in-one location. A third approach is the MSU, where tPA can be administered and imaging can be done as the patient is being transported to the appropriate stroke center.

Each of these approaches will have different challenges that are specific to the system and region. The centralized or mothership system does come at a significant burden to any ambulance system because prehospital personnel would

a. Direct transfer to an endovascular center compared to transfer to the closest stroke center in acute stroke patients with suspected large vessel occlusion (NCT02795962).

Figure 2. Approaches to consider for stroke care systems. In the drip-and-ship model (A), a patient is brought to a tPA-capable hospital for imaging and tPA administration and then may be moved to a thrombectomy-ready hospital. In the mothership model, the patient is brought to a hospital for imaging, tPA, and thrombectomy in the same center. In the mobile stroke unit (MSU) model, an ambulance with teleradiology determines if tPA is indicated, and ambulance personnel may administer tPA and then bring the patient to the appropriate hospital depending on whether or not thrombectomy is indicated.

participate in longer transports to less familiar parts of town. Taking ambulances out of a local region to transport patients to higher-tier care centers makes fewer ambulances available to respond to other calls. Some regions are further challenged by variable traffic patterns and long transport times in between hospitals. Defining the maximum transport time acceptable for bypassing to the thrombectomy-capable and comprehensive centers is vital. Although the AHA has recommended a 20-minute transport time, each region will have to determine their maximum transport times based on regional characteristics.

An area of active investigation in the BEST-MSU[b] trial, MSUs may reduce time to thrombolysis with tPA for patients with ischemic stroke. Costs of maintaining an MSU are high, however, and methods to optimize response to patients with LVO still need to be developed. Identification of LVO in the field by MSUs may have a role in the development of regional stroke systems, if it is shown to be effective and not cost prohibitive.

Communication and Coordination of Care

Relationships between different types of stroke centers (ie, ASRs, PSCs, TSCs, and CSCs) are vital to any of the approaches described. All prehospital stroke-screening instruments will miss some patients with LVO who can be identified in the ED and these patients will need to be appropriately screened for tPA administrations and then transported as needed for thrombectomy. Because up to half of patients with stroke present to the ED though a non-EMS pathway, the importance of regional care systems and communication between nonstroke-center hospitals and regional stroke centers for help in diagnosis, treatment, and triage cannot be understated.

Overtriage and Undertriage

Current prehospital LVO triage scales may delay administration of tPA in patients without LVO. Treatment of acute ischemic stroke (AIS) with tPA[18] is highly time dependent, and every 15-minute delay in administering tPA reduces the chance of functional recovery and increases mortality and symptomatic intracerebral hemorrhage (ICH).[19,20] If a false-positive prehospital LVO-stroke triage assessment (over-triage) leads EMS to extend transport times by bypassing an intravenous (IV) tPA-capable hospital in favor of a more distant stroke center with a higher level of care (the mothership model), the delay in tPA administration could contribute to worse outcomes. Such over-triage may decrease efficiency of nonthrombectomy hospitals because of reduced volume and experience,[21] whereas more specialized centers may become crowded with patients who don't require that level of care, which could reduce capacity of that center to accept transfers of complex cases as a result of increased volume.[22]

Stopping for tPA at a nonthrombectomy hospital (the drip-and-ship model) delays endovascular thrombectomy. Endovascular thrombectomy[1,23-26] is also highly time-dependent, and a false-negative assessment using a prehospital LVO tool (under-triage) may route a patient with AIS-LVO to a hospital without thrombectomy capabilities. Secondary transfer after tPA administration to a thrombectomy-enabled care center can delay thrombectomy by 95 to 109 minutes.[26,27] Despite rigorous process-improvement initiatives, transfer delays of more than an hour are common.[28] Every 4-minute delay of thrombectomy increases the degree of 90-day disability (modified Rankin Scale [mRS] shift) for 1 of 100 treated patients and every hour in delay to thrombectomy increases morbidity.[29] Mistriage is associated with an absolute

b. Benefits of stroke treatment delivered using a mobile stroke unit (NCT02190500).

8% decrease in freedom from disability and an absolute 9% decrease in functional independence.[27]

Modern EMSs exist to identify and stabilize patients with time-dependent emergencies while ensuring the right patient gets to the right hospital in the right amount of time. This art of triage may bypass the closest facility for the most appropriate facility and, when performed correctly, improves outcomes after trauma,[30] acute myocardial infarction,[31,32] and out-of-hospital cardiac arrest.[33] Proper EMS triage can be the most cost-effective strategy in developing care systems and is favored over creation of more specialty receiving facilities.[34] Under-triage, or taking a patient to a lower level of care than optimal, introduces delays from subsequently needed secondary transfer. Emergent definitive neurosurgical care with ventriculostomy, decompressive craniectomy, or aneurysmal clipping or coiling for ICH[35,36] and subarachnoid hemorrhage (SAH),[37-40] is unnecessarily delayed.

Almost all published research related to existing EMS stroke-screening tools focuses on identifying patients with LVO; this conflicts with the purpose of triage itself—getting the right patient to the right place in the right amount of time—regardless of diagnosis. A patient with a positive prehospital severity score and a large ICH, which requires immediate surgical decompression, may be considered a false positive even though the tool resulted in appropriate routing to the appropriate care center in these studies because the patient did not have an LVO. Similarly, a patient with a low probability of LVO on a stroke-screening tool and a distal arterial occlusion might be considered a false negative, even though they would not have qualified for thrombectomy based on current guidelines[4] and could be cared for at the PSC.

Summary and Future Directions

Important advances in AIS treatment have been achieved, including demonstration of benefit from prehospital care systems,[41] care delivery on stroke units,[42] reperfusion therapy with tPA,[18] and reperfusion therapy with endovascular thrombectomy[1]; however, there are still limitations and challenges to address.

Intravenous tPA can only be administered after neuroimaging has ruled out ICH,[43-45] and although the benefits are strongly time-dependent, in current clinical practice in the US, tPA is not started until an average of 2 hours and 20 minutes after onset, well after the accumulation of substantial irreversible injury in most patients.[46] Endovascular therapy is indicated in only 3% to10% of patients with AIS, and these patients have to be transported to a tertiary neuroendovascular center. Although the benefit of endovascular therapy is also strongly time-dependent,[24,25] reperfusion is currently not achieved until a median of 4 hours and 45 minutes from onset.[1] Because substantial brain injury accrues before reperfusion can be achieved, even among patients with AIS treated with endovascular therapy, 73% of patients have outcomes of disability or death.[1]

Improvements in the care systems to deliver appropriate patients to endovascular-capable hospitals are needed. An ideal stroke care system would reliably identify the presence of LVO among patients evaluated in the field and route them urgently to the most appropriate facility. Regional cooperation would lead to maximization of resources by concentrating endovascular care in the most geographically appropriate locations. This care system will need to include nonendovascular PSCs for rapid tPA administration, endovascular PSCs for rapid endovascular treatment without the ability to manage the most complicated cases, and CSCs providing round-the-clock care (24 hours/day, 7 days/week) for the most complex patients. Centralization of the triage process in the local EMS agency and cooperation and data sharing among all stakeholders will also be essential.

There is no easy answer to the question of primary, comprehensive, or thrombectomy-capable. The question will be different for every individual patient and every stroke care system. It is only by coordination between emergency medical providers, stroke care systems, neurologists, radiologists, and neurosurgeons that we can maximize the potential of prehospital stroke care and improve outcomes for patients with stroke. ■

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Disclosures

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