Hospital-to-Hospital Transfer Delays in Hyperacute Stroke: Known Causes and Gaps in Knowledge

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Abstract

Background

Transfer challenges from primary stroke centers and acute stroke ready hospitals (PSC/ASRH) to a higher level of care are excessive. This narrative review examines the published literature for factors within and external to PSC/ASRH emergency departments that contribute to delays in the transfer of large vessel occlusion (LVO) patients to a higher level of care for thrombectomy.

Methods

A review of the literature was conducted incorporating findings from January 1996 to April 2020. Reference software was utilized to organize and track references. Retrieved papers were screened first by abstract to eliminate non-pertinent studies; papers selected for full review were then fully examined for relevance, and those retained were subsequently divided into thematic groups based on content.

Results

Guideline standardization of intrahospital practices and associated performance metrics, along with prehospital provider education and training have contributed to improved acute stroke service efficiency. Factors associated with transfer delays have not been identified nor quantified, yet delays contribute to significantly worse patient outcomes. Calls for bypass of lower levels of care with direct transport to CSC are fueled primarily by assumptions of poor PSC/ASRH internal performance.

Conclusions

Although transport delay times have been quantified as excessive, the reasons for delays are not fully understood. Additional research is warranted to fully understand why delays occur.

INTRODUCTION

Stroke remains a leading cause of disability worldwide and can be physically, financially and, socially devastating. Recent advancements in acute treatment by mechanical thrombectomy have been shown to improve patient outcomes for large vessel
occlusion (LVO) ischemic stroke patients out to 24 hours from symptom onset in select cases. However, for most patients treatment remains time-dependent and, now more than ever developing efficient stroke systems of care capable of rapid interfacility transport is of utmost importance.

Best practice within a stroke system includes prioritizing LVO transfer to the most appropriate facility since delays in transport have been associated with poor patient outcomes. However, standardized guidelines have not been established to support change throughout the entire system of care that would ensure rapid transport, instead favoring the transport of suspected acute stroke patients to the nearest Stroke Center hospital. Furthermore, factors causative of delayed patient transfer from Primary Stroke Centers (PSC) to Comprehensive Stroke Centers (CSC) have not been well defined by credentialing organizations or guideline developers. Despite lack of study and accrediting organization guidance, it is often assumed that slow emergency department processes within the PSC are the primary contributor to delayed transport. It can be argued that without a thorough understanding of all potential contributors to transport delay, strategies that aim to reduce them cannot be developed with any degree of precision. Therefore, this review examines the published literature to identify factors within and external to transferring facilities located in the United States that contribute to delays in the transfer process in an effort to frame the design of future study and the crafting of interventions capable of improving performance of stroke systems of care.

Methods
A narrative review of the literature on stroke system transfer delays was performed utilizing published articles between January 1996 and April 2020. Zotero was utilized to organize and track references. The publication date was established to include the time following publication of the NINDS rt-PA Stroke Study in the New England Journal of Medicine in December 1995; these dates ensured capture of pertinent systems of care developments associated with reperfusion therapy, and known methods to optimize systems of care, as well as allowing analyses of apparent gaps in knowledge about systems contributors that may account for transfer delays. Search terms were selected using PubMed and included: Stroke AND large vessel occlusion AND stroke protocol; transfer AND delay AND emergency NOT pediatrics; emergency medical services AND stroke AND transfer. Retrieved papers were screened first by abstract to eliminate unrelated studies; papers selected for full review were then fully examined for relevance, and those retained were subsequently divided into thematic groups based on content.

Results
Resource Availability is Associated with Improved Stroke Outcomes
Variations in patient outcomes are related to the availability of resources such as vascular neurologists, dedicated stroke units, and the availability of endovascular therapies. This finding is consistent with the initial recommendations by the NINDS rt-PA Study Investigators who in 1996 first suggested the need for Stroke Centers development using a similar model to that of Trauma Center credentialing. In 2000, the Brain Attack Coalition was the first to recommend specific resources that should be required by Stroke Centers, delineating center level by resource capabilities. Regulatory agencies including The Joint Commission and later Det Norske Veritas led
the development of formal credentialing processes for Stroke Center hospitals. Since its initiation in 2003, the Stroke Center Certification process has developed multiple credentialing levels based on resource availability. The evolution of evidence-based process metrics for acute stroke has been woven into the fabric of Stroke Center performance and contributes to practice standardization that benefits patient outcomes.28

Organizational certification as a Stroke Center has been associated with improved hospital performance and with patient care standardization supported by acute stroke performance metric benchmarking; ultimately Stroke Center certification has been shown to lead to improved patient outcomes and important reductions in complications.29,30 Registry systems have evolved to include standard stroke performance metrics, and participation in a national stroke registry that offers performance benchmarking is now a Centers for Medicare and Medicaid Services (CMS) requirement for Stroke Centers.

**Prehospital Emergency Medical Services (EMS) Personnel Education and Training is Associated with Improved Stroke Outcomes**

Prehospital providers are tasked with the initial responsibility of ensuring fast and appropriate triage of suspected stroke patients to Stroke Centers.31–36 State regulatory requirements for ambulance personnel routinely include annual education and training on stroke identification and prehospital stroke scales are commonly used by ambulance personnel to assist in the early identification of stroke patients. Guidelines have evolved to specify the type of care that emergency responders should include in their management of stroke patients (i.e. avoidance of glucose-based IV solutions, maintaining nil per os status, etc.), while also mandating collection of essential assessment data including the medical history, medications, and *time last known well*.

Some professional guidelines recommend transport to the closest Stroke Center, whereas some more recent guidelines advocate using what is referred to as *LVO clinical* scales to determine the appropriate level of Stroke Center for patient transport. While the use of LVO scales has the potential to improve field triage of stroke patients to centers with appropriate resources, overall they lack precision in LVO detection, with 20% of patients on average not actually having an LVO.37 Additionally, EMS compliance with the use of LVO protocols is inconsistent23 and this may be due to high rates of turnover31,38,39 or a failure to understand how best to perform the more complex assessment components within these scales.40,41 Accurate EMS dispatch and on-scene EMS recognition of stroke symptoms have been shown to improve patient outcomes by reducing scene time and offeringprehospital notification, resulting in faster emergency department arrival to initial head computed tomography (CT) times.42 Few states have developed protocols to bypass hospitals with limited resources. However, in many states, no guidelines for stroke-specific transport exist; therefore, patients are transported to the facility of their choice,43 even if this facility is incapable of managing acute stroke patients. Given that EMS diagnostic accuracy is modest, ambulance transport of suspected stroke patients to the wrong level of stroke services may result in significant delays in the provision of definitive disability-reducing and life-saving care.23,44

The use of mobile stroke units (MSU) has recently been associated with appropriate and accurate ambulance triage of stroke patients than the use of LVO scales. Additionally,
MSU patient management has been shown to improve 3-month outcomes in patients treated with alteplase. However, MSUs are not widely available across throughout America and the world. Currently, researchers are attempting to find a reliable tool to aid early detection of stroke and appropriate allocation of resources, including exploration of telemedicine cameras within regular EMS ambulances to improve scene clinical assessment and stroke biomarker testing that may direct early field treatment.

Prehospital transfer delays have been associated with worse outcomes after trauma, stroke, and, myocardial infarction. In contrast, the use of care algorithms have been shown to streamline care and improve outcomes. The American Heart Association initiated Mission: Lifeline to enhance systems processes and ultimately improve the quality of care delivered to patients suffering life-threatening events such as ST-segment elevated myocardial infarction (STEMI), non-ST segment elevated myocardial infarction (NSTEMI), and out of hospital cardiac arrest. These programs incorporated a multi-team approach to cardiac care and stressed the importance of providing seamless care to those needing it most. The Mission: Lifeline initiative also called for additional metrics to eliminate time delays and defined expected transfer times of less than one-hundred and twenty minutes.

In comparison, programs supporting acute stroke patients currently only include the door-in door-out (DIDO) metric, although it lacks detail allowing it to capture reasons for delay; because of this, today, no quality metrics exist to promote an understanding of contributors to transfer delays in LVO patients.

Internal Emergency Department System Efficiencies
Reduction in the transport and treatment times within the STEMI population relied on several factors including infrastructure, logistics, and operation of the interprofessional teams. In 2006, Saver quantified neurons at risk of death when reperfusion is delayed, estimating that approximately 1.9 billion neurons are lost with each minute that passes. Over the past 28 years since approval of alteplase intravenous thrombolysis for stroke, emergency department teams have improved internal performance efficiency, moving diagnosis and treatment times from a 60 minute goal, to less than a 30 minute goal.

Zachrison and colleagues examined the benefits of hospitals working together to create a synergistic, high-functioning stroke system of care, showing that when relationships are built between transferring and receiving hospitals, that this strengthened communication and positively impacted the quality of care. As Saver’s work suggested, clearly every second counts when it comes to diagnosis and emergent management of acute stroke patients.

The DIDO Movement
The negative impact of being transferred from one facility to another includes higher morbidity and mortality rates. The DIDO metric aims to capture the time from entry into a lower level of care hospital to the time that the patient leaves with a transport service for the higher level of care hospital. Measurement of DIDO has gained momentum since 2019 within American Stroke Centers, although clear reasons for long DIDO times remain evasive. The average time reported for stroke patients to be transferred from lower to higher levels of care for thrombectomy is 180 minutes on average, with interfacility transfer causing at least a 100 minute delay to start of thrombectomy. With the quality metric for emergency department arrival to diagnosis and door to needle time moving to under 30 minutes, recommendations for transfer or
DIDO times within no more than 40 minutes have been proposed. Primary Stroke Center protocols have been developed to enable early vessel imaging; additionally, cloud-based artificial intelligence-supported neuroimaging transfer with both originated PSC hospitals and affiliated CSC providers facilitates early diagnosis and transport mobilization to improve DIDO times. But, a significant gap in knowledge of what contributes to delays up to 180 minutes exists, with no objective data available on stroke transfer delays in the published literature.

In elective transfers of non-traumatic surgical patients, delays have been attributed to clinical decision-making regarding the transfer indication, administrative issues, and bed availability. Lack of health insurance has also been found to be an independent risk factor for inter-facility transfer delay in patients with STEMI. While little is known about causes of DIDO delays in acute stroke patients, recommendations for PSC bypass with direct ambulance transfer of all suspected stroke patients to a CSC have been made.

**Discussion**

This review shows that strategies including standardized performance guidelines, quality metrics, paramedic education and training, mobile stroke units and potentially other evolving technologies including artificial intelligence-supported neuroimaging are facilitating improved early diagnosis and treatment. Additionally, the significant risk to health associated with the need for inter-facility transfer is well known, as are the very real delays that are currently experienced by patients. However, a large gap remains in understanding contributors to delayed transfer from lower levels of stroke services to CSC hospitals, with many assuming faults lie solely within the transferring hospitals.

As advances in stroke care evolve, so will the need for optimization of stroke systems of care. With recent recommendations suggesting that the time from hospital arrival to departure for a higher level of care should not exceed 60 minutes, knowledge of specific barriers to efficient transfer must become known; without this knowledge, methods capable of driving improvement cannot be created or effectively tested. Rapid transfer of interventional cardiology patients targets an aggressive 30-minute DIDO time; similar targets could ultimately be extended to include LVO patients and other critical stroke emergencies such as intracerebral and subarachnoid hemorrhage. Yet even the cardiac literature fails to identify and quantify the contribution of systemwide barriers to achievement of this aggressive 30-minute goal, although DIDO times greater than 30 minutes have been associated with a 5.5% increase in the risk of in-hospital mortality in patients with STEMI transferred for PCI.

While Stroke Center performance has significantly benefitted from the processes identified in this review, DIDO times remain quite long. Whether complete ambulance bypass of lower level Stroke Centers is needed, with redistribution of 100% of suspected strokes to CSC remains unknown, yet there is a growing call for this among neurointerventionalist physicians. The consequences of stroke ambulance bypass would create the need for significant resource redistribution away from PSC hospitals to CSC hospitals, including physician, nurse, and therapist manpower, along with an additional allocation of hospital beds to manage this shift in volume. Additionally, since a large volume of stroke patients may not require CSC-level services, bypass could displace a significant number of patients that
may have been able to receive evidence-based acute stroke services closer to their homes. A redistribution of resources away from PSC hospitals would also likely result in the complete removal of stroke services from these centers altogether, and this could devastate patient care for stroke patients that arrive in err to a hospital lacking resources and manpower to emergently respond to stroke symptoms. Given that approximately 45% of patients arrive to hospitals in private automobiles instead of calling for emergency ambulance response, the potential that the wrong hospital could be selected for acute stroke patient transport is very likely.

This review suggests that contributors to DIDO delays are likely multifactorial existing within transferring centers’ emergency departments, telemedicine responders, transport agencies, and receiving CSC hospitals. Furthermore, public policy may contribute to transfer delays by mandating requirements for transport providers, such as critical care certified paramedics for transfer of LVO and/or intravenous thrombolysis-treated patients which may not be widely available; this calls into question the need for CSCs to maintain their own ground and/or air transport services staffed by stroke specialists or MSUs, adding additional complexity and expenses for CSC hospitals. Shortages of specialty stroke-trained nurses and physicians at both the transferring and receiving hospital sites may also be a contributor, as treatment with vasoactive medications or thrombolitics requires expertise to prescribe and oversee management, including during the actual transport process. Additionally, bed availability within CSCs themselves is often contingent upon the availability of both nurse staffing and inpatient bed availability, and therefore may limit the availability of higher-level services. While we need to fully understand the implications associated with hospital bypass, we also need to know how, when, and why barriers to streamlined transfer exist.

Conclusions

For almost 3 decades, hyperacute stroke diagnosis and treatment have demanded improved attention to treatment times supported by highly efficient services, and while recent work suggests that advanced imaging can expand treatment time windows overall, improved outcomes are associated with rapid reperfusion. Knowledge is lacking about why transfer delays occur for acute stroke patients. Operating on assumptions that slow internal PSC processes are the chief cause of transfer delays despite findings show significant improvements in diagnosis and treatment efficiencies, seems illogical. Research is necessary to fill the gap in knowledge that limits our understanding of contributors to transfer delay, so that interventions may be developed and tested to improve the seamless management of all components within stroke systems of care.

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References

Patterson, JL


50. Dharap SB, Kamath S, Kumar V. Does prehospital time affect survival of major trauma patients where there is no prehospital care? J Postgrad Med. 2017;63(3):169-175. doi:10.4103/0022-3859.201417


61. Writing Committee Members, Antman EM, Anbe DT, et al. ACC/AHA


76. Optimal Transport Destination for Ischemic Stroke Patients With Unknown Vessel Status. doi:10.1161/STROKEAHA.117.017281
