Improving Transfer Times for Acute Ischemic Stroke Patients to a Comprehensive Stroke Center

Thomas V. Kodankandath, MD,* Paul Wright, MD,* Paul M. Power, EMT-P,† Marcella De Geronimo, MS,‡ Richard B. Libman, MD,* Thomas Kwiatkowski, MD,§ and Jeffrey M. Katz, MD*

Background and Objective: The transfer of acute ischemic stroke (AIS) patients to a comprehensive stroke center (CSC) must be rapid. Delays pose an obstacle to time-sensitive stroke treatments and, therefore, increase the likelihood of exclusion from endovascular stroke therapy. This study aims to evaluate the impact of the Stroke Rescue Program, with its goal of minimizing interfacility transfer delays and increasing the number of transport times completed within 60 minutes. *Methods:* The Stroke Rescue Program was initiated to facilitate the rapid transfer of AIS patients from regional primary stroke centers (PSCs) to the network's CSC. The transfer process was divided into 3 time elements: transport 1 time (initial phone call from the PSC until emergency medical service [EMS] arrival at the PSC), emergency department (ED) time (EMS PSC arrival to PSC departure), and transport 2 time (PSC departure to CSC arrival). The total transport time target was set at less than 60 minutes. Protocols and procedures were implemented with a focus on decreasing the ED time. *Results:* Comparing baseline (preimplementation) quarter (n = 21) to postproject quarter (1 year later, n = 31), the percent transported within 60 minutes increased from 62% to 81%. A statistically significant improvement was seen for both median ED time (23 minutes versus 14 minutes; U = 171, $P < .01$) and median total transport time (56 minutes versus 44 minutes; $U = 199$, $P < .05$). *Conclusion:* Interfacility transfer protocols minimizing the time paramedics spend in a PSC ED can significantly reduce total transfer time to a comprehensive stroke center. **Key Words:** Acute ischemic stroke—endovascular stroke therapy—drip-and-ship transfer—stroke quality—stroke transfer—thrombolysis.

Introduction

Comprehensive stroke centers (CSCs) provide acute ischemic stroke (AIS) patients with advanced diagnostic and treatment procedures that are not available at primary stroke centers (PSCs). These procedures include a higher level of medical and surgical care and endovascular stroke therapy (EST).[1] Indications for an immediate transfer to a CSC for stroke intervention include the following: (1) AIS patients with a baseline prestroke modified Rankin Scale score less than 2; (2) significant neurological deficits (National Institutes of Health Stroke Scale score of at least 6) that are thought to be attributable to a large intracranial arterial occlusion; (3) either not an intravenous (IV) tissue plasminogen activator (tPA) candidate or have not rapidly improved after IV tPA; and (4) still within 6 hours from

From the *Department of Neurology, North Shore University Hospital, Hofstra Northwell School of Medicine, Manhasset, New York; †Department of Workforce Safety, Northwell Health; ‡Department of Informatics and Quality, Northwell Health; and §Department of Emergency Medicine, Hofstra Northwell School of Medicine.

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Address correspondence to Jeffrey M. Katz, MD, North Shore University Hospital, Department of Neurology, 300 Community Drive, 9 Tower, Manhasset, NY, 11030, United States. E-mail: jkatz2@northwell.edu.

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stroke symptom onset.[2] Patients with suspected or confirmed basilar artery occlusion, without large brainstem infarction, should also be considered for rapid transfer to a CSC even if last known well is beyond 6 hours.

Delays in transfer are a major contributing factor to the exclusion of otherwise eligible EST candidates.[3] Studies show that the most favorable clinical outcomes following catheter-based stroke therapy are associated with shorter onset-to-recanalization times.[4-6] Since multiple randomized controlled trials confirmed the benefit of EST compared to medical therapy alone, a significant focus has been on reducing door-to-groin puncture times. Rapid intervention was an inclusion criterion in the ESCAPE and SWIFT PRIME trials, and was defined as a computed tomography (CT)-to-groin puncture time of less than 60 and 70 minutes, respectively.[7,8] To optimize the benefit from catheter-based interventions, the transfer of AIS patients to a CSC must be rapid.

Here we describe the implementation of the "Stroke Rescue Program" as a performance improvement initiative created to minimize delays in the transportation of AIS patients to a CSC. Stroke rescue is defined as the rapid transfer of an AIS patient from a PSC to a CSC for the purpose of potential EST. We hypothesized that by dividing the transfer process into measurable time elements, and developing a protocol to reduce the time interval that the emergency medical service (EMS) provider spends in the PSC, transport times would improve.

Methods

The Stroke Rescue Program was created within a large metropolitan health system in New York to facilitate the rapid transfer of AIS patients from regional PSCs to the network's CSC. Sixteen PSC hospitals are included in the stroke referral network and a single EMS system provides transports. Patients who underwent stroke rescue to the CSC in the baseline quarter (before project implementation) were compared to patients transported in the quarter 1 year postproject initiation. There were no exclusion criteria. Designated time elements include transport 1 time (initial phone call from the PSC until EMS arrival at the PSC), ED time (EMS arrival at the PSC to departure with the patient from the PSC), and transport 2 time (EMS PSC departure to CSC arrival). The total transport time target (initial phone call from the PSC to patient arrival in the CSC emergency department) was set at less than 60 minutes.

A specific protocol to instill a "grab-and-go" mentality was created for the EMS to reduce ED time. Paperwork requirements were minimized by direct physician-to-physician transfer of information and by requiring the EMS to collect only essential data such as tPA dose and administration times. All medications were held except for those deemed critical, such as tPA and antihypertensive infusions. Transport 1 time was targeted by a new EMS dispatching protocol utilizing an enhanced computer-aided dispatch system, Mobile Area Routing and Vehicle Location Information System (MARVLIS). This technology combines geographic information systems with wireless communication and GPS to achieve efficient dispatch times for stroke rescue transports. All stroke rescue patients were transferred as critical "lights and siren" transports.

A centralized transfer center, a single EMS dispatch center, and a stroke rescue hotline were created to simplify the referral process. All EMS paramedics functioning within the stroke rescue system were trained in advanced critical care practices, including tPA and antihypertensive infusions. Time was measured in minutes for the baseline quarter and the postimplementation quarter.

The primary outcome for the present study was to determine the effect of an interfacility transport protocol for AIS patients by measuring the ED time and the total transport time, along with the percent of transport times within 60 minutes. The secondary outcome was the protocol influence on postintervention transport 1 and transport 2 times.

Comparison of transport times between the baseline quarter and the postimplementation quarter was analyzed using a nonparametric Mann–Whitney *U*-test. Pearson's chi-square test was used to test the change in percentage of transport time within 60 minutes. Statistical significance was defined as a P value less than .05.

Results

During the 18-month study period (3-month baseline quarter, 12-month implementation period, and 3-month postimplementation quarter), 128 patients underwent stroke rescue. The median PSC to CSC distance was 14.4 mi (range 3.0-32.1 mi). Ischemic stroke was confirmed in 116 (91%) patients, and 65 (51%) patients were "drip-and-ship" transports (IV tPA infusion during transport 2).

Comparing the baseline quarter (n = 21) to the postimplementation quarter (n = 31), a statistically significant reduction was seen in the median ED time, from 23 minutes preintervention to 14 minutes post intervention ($U = 171$, $P < .01$). The median total transport time was also significantly reduced from 56 to 44 minutes ($U = 199$, $P < .05$). The percent transported within 60 minutes increased from 62% at baseline to 81% ($P = .135$). The median preintervention transport 1 and transport 2 times were 14 and 20 minutes, respectively, compared to 12 and 18 minutes post intervention. Only 13 stroke rescue patients underwent endovascular stroke intervention during the comparison quarters, and the frequency of EST did not change between the baseline and postimplementation phases. There were no adverse events or errors associated with the alterations of information transfer used to reduce ED time.

Discussion

Dividing the AIS patient transfer process into 3 distinct time elements with focused efforts on the ED time re-

sulted in a statistically significant decrease in the total transfer time. This finding was primarily due to the significant reduction in the median time spent by the EMS in the referring ED. The observed decrease in ED time may have been secondary to improved EMS training, and reduction in the time spent retrieving clinical information and managing noncritical medications. Interventions targeting transport 1 time were not associated with statistically significant transport time reductions, and although the percent transported within the 60-minute target increased by 19%, this difference did not reach statistical significance. Reducing transfer times had no effect on EST frequency. No adverse events resulting from this initiative were observed.

Transfer delay is the second most common reason (14%) next to clinical contraindications (40%) for EST exclusion.[3] A prior study found that admission of patients by direct referral from a regional hospital without CT imaging shortens the time to EST initiation.[9] This, however, potentially delays IV tPA administration, as EST cannot be provided without brain imaging. The drip-and-ship transfer of AIS patients has been shown to safely and effectively increase the rate of stroke interventions.[10] Nonetheless, the drip-and-ship paradigm is also associated with longer transfer times, causing endovascular procedural delays.[5] Another approach includes avoidance of sophisticated imaging such as CT perfusion or magnetic resonance imaging in patients arriving soon after symptom onset.[4] In SWIFT PRIME, perfusion imaging prolonged the time to intervention in transfer patients compared to nontransfer patients.[5] Future technological advances, such as mobile stroke units, may also play a role in reducing onset-to-treatment delays for AIS patients qualifying for EST.

Reducing the time from stroke onset to reperfusion improves clinical outcomes. A higher frequency of good clinical outcomes in the STAR registry compared to the IMS 3 trial was partially a result of improved in-hospital workflow efficiencies.[11,12] The STAR registry demonstrated that the odds of a good clinical outcome were reduced by 38% for every 1-hour delay in revascularization.[13] Only 4%-14% of AIS patients are eligible for EST, and it is unrealistic to expect every hospital to provide endovascular services in the future.[14] Still, all hospitals receiving AIS patients must be able to diagnose an ischemic stroke and to identify potential large intracranial arterial occlusions amenable to EST. Concurrent activation of the endovascular team in parallel with IV tPA initiation at the referring hospital has also been shown to reduce door-to-groin times.[15] Shorter door-in–door-out times for patients with ST-elevation myocardial infarction (STEMI), requiring transfer for percutaneous intervention, are independently associated with prehospital, ED, and in-hospital care process improvement. A coordinated approach to STEMI care at nonpercutaneous intervention hospitals, optimizing the above processes, has led to improvement in STEMI transfer efficiency.[16] Hence, optimization of PSCs in regard to shorter door-in–door-out times for patients with AIS will require a collaborative effort between EMS, neurologists from the referring and accepting hospitals, and nursing and emergency medicine staff.

Major limitations of our study include the small sample size and the lack of a control arm to exclude additional quality improvements over time as contributing factors to our observed transfer time reductions. A small sample size may have contributed to the fact that, despite a 23% relative increase in the percentage of patients meeting the 1-hour transfer time target, this finding did not reach statistical significance. The small sample size also limits our ability to show any clinical benefit from this initiative, and is one of the numerous reasons why EST frequency was not observed to increase over the study period as might be expected. Other limitations include our inability to specify which intervention may have had the greatest impact on reducing transfer delay, and the fact that the presence of other potential confounding variables, such as individual patient characteristics, including stroke severity and overall medical stability, was not accounted for in the present study. Ideally, our results should be replicated in another study with a larger sample size and with a concurrent control group to determine whether or not this program can be translated to other settings.

Despite these limitations, the concept of dividing the transfer process into measurable and targetable time elements has merit, and directing efforts and resources at reducing ED time may be the simplest solution having potentially the greatest impact on the interfacility transfer process. With the goal of improving AIS patient outcomes by increasing the proportion of eligible patients undergoing EST and decreasing onset-to-recanalization times, reducing interfacility transfer delays is conceptually crucial, as are performance improvement initiatives targeting PSC door time to CSC contact time and CSC door-to-groin puncture and recanalization times. Improving the efficiency of the latter is significantly associated with better functional outcomes in this population.[6] Further study is needed to determine whether improved stroke network efficiency before CSC arrival translates into better clinical outcomes, but the concept of “time is brain” supports this approach.

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