Rethinking Prehospital Stroke Notification: Assessing Utility of Emergency Medical Services Impression and Cincinnati Prehospital Stroke Scale

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Background and Purpose: Although prehospital stroke notification has improved stroke treatment, incorporation of these systems into existing infrastructure has resulted in new challenges. The goal of our study was to design an effective prehospital notification system that allows for early and accurate identification of patients presenting with acute stroke. *Methods:* We conducted a retrospective single-center cohort study of patients presenting with suspicion of acute stroke from 2014 to 2015. Data recorded included patient demographics, time of symptom onset, Cincinnati Prehospital Stroke Scale (CPSS) score, Glasgow Coma Scale score, National Institutes of Health Stroke Scale (NIHSS) score, emergency medical services (EMS) impression, acute stroke pager activation, acute intervention, and discharge diagnosis. Univariate logistic regression was performed with discharge diagnosis of stroke as the end point. *Results:* A total of 130 patients were included in the analysis; 96 patients were discharged with a diagnosis of stroke or transient ischemic attack. Both NIHSS and the presence of face, arm and speech abnormalities on CPSS were significantly higher in patients with stroke ($P < .05$). EMS correctly recognized stroke in 77.1% of cases but falsely identified stroke in 85.3% of negative cases. CPSS identified 75% of acute stroke cases, but specificity was poor at only 20.6%. All patients receiving intervention had acute stroke pager activation in Emergency Department. *Conclusions:* Prehospital stroke notification systems utilizing EMS impressions and stroke screening tools are sensitive but lack appropriate specificity required for modern acute stroke systems of care. Better solutions must be explored so that prehospital notification can keep pace with advances in acute stroke treatment. **Key Words:** Emergency medical service—prehospital notification—stroke—telemedicine.

Introduction

Treatment of acute ischemic stroke has seen tremendous advancement over the last 20 years, first with the introduction of intravenous recombinant tissue plasminogen activator (rt-PA), and more recently, with numerous positive clinical trials promoting endovascular therapy.[1-3] The expression "time is brain" has become the mantra of acute stroke treatment, as an estimated 1.9 million neurons are lost each minute that a stroke is left untreated,[4] and patient outcomes are substantially improved with shorter treatment times.[5,6] As a result, emphasis has been placed on designing systems of care that can rapidly triage patients with acute strokes to deliver treatment with minimal delay.

Approximately 50% of patients with acute ischemic stroke utilize emergency medical services (EMS) to reach the hospital[7]; therefore, EMS personnel have become crucial

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Received September 27, 2017; revision received October 20, 2017; accepted October 29, 2017.
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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2017.10.036

stakeholders in the continuous improvement of acute stroke management. Multiple national guidelines[8,9] have recognized the growing importance of prehospital stroke care by calling for EMS providers to provide early prenotification to the receiving hospital when stroke is recognized in the field.[9] Prehospital notification allows for rapid mobilization of downstream resources, including stroke team activation and access to computed tomography scanners, to expedite intra-hospital triage and improve treatment times. Moreover, it offers a window of opportunity for providers to review relevant medical history and inclusion and exclusion criteria for rt-PA. The implementation of prehospital notification systems have been one of the most successful interventions globally in reducing time to treatment and improving patient outcomes.[6,10-17]

Despite advantages of prehospital notification systems, EMS personnel lack the necessary time and training to perform detailed neurologic assessments. Several scales have been designed and validated to help providers recognize stroke in the field, including the Los Angeles prehospital stroke screen (LAPSS) and the Cincinnati Prehospital Stroke Scale (CPSS).[18-20] Although initial studies showed promising sensitivity and specificity, further reviews demonstrated wide performance variability in clinical practice.[20,21] Major contributors to this variability included underutilization of stroke recognition tools, lack of appropriate education of EMS providers, and the inherent complexity of acute stroke presentations.[22-24]

The low specificity of EMS prehospital notification has led to concerns about effective resource allocation. With each notification, stroke teams are mobilized, computed tomography scanners are reserved, and clinicians are required to step away from other clinical obligations to rapidly triage the incoming patient. High levels of false positives may become overly burdensome for the system, and potentially detrimental to the care of other patients. Therefore, the goal of our study was to design an effective prehospital notification system that allows for early and accurate identification of patients presenting with acute stroke.

Materials and Methods

This study was a retrospective single center cohort study approved by the Mayo Clinic Institutional Review Board, who waived the need to obtain patient consent. The study population included all patients who were identified with potential stroke by our emergency dispatchers at the time of EMS dispatch between January 1, 2014, and December 31, 2015. All patients were transported by ground ambulance to the Mayo Clinic Hospital—St. Mary's Campus Emergency Department (ED) and matched to the Gold Cross EMS database and Mayo Clinic electronic medical record (EMR). Gold Cross is the sole EMS provider within the city of Rochester, Minnesota, and it maintains an electronic database of all patient encounters including date of service, patient name, sex, date of birth, chief complaint, transport times, impression of diagnosis by EMS provider, vital signs, Glasgow Coma Score (GCS), blood glucose, treatment summary, and brief narrative of the encounter. Gold Cross utilizes the CPSS to evaluate all patients with suspected stroke. All Gold Cross paramedics complete a 1-hour online module annually on stroke recognition and assessment in the field as part of their required job training. During the study period, our system did not yet require prehospital notification by EMS.

Data collected from the Gold Cross database for this study included 3 time measures: (1) response time (EMS dispatch to arrival on scene), (2) on-scene time, and (3) transport time. Also included were finger stick glucose; CPSS, subdivided into components of facial droop, arm drift, and speech; GCS, subdivided into eyes, verbal, and motor; dispatcher impression of diagnosis; and EMS impression of diagnosis. EMS impression of diagnosis was recorded as a stroke if primary or secondary diagnosis included the words "transient ischemic attack (TIA)" or "cerebrovascular accident (CVA)." Transport times were recorded in minutes. Gold Cross data were then matched manually with hospital EMR by correlating name, gender, and date of birth. These were confirmed by matching date of EMS with date of ED visit. All patients included in initial population were matched with corresponding Mayo Clinic EMR.

Review of EMR resulted in the collection of the following data: patient demographics; last known well time; acute stroke pager (ASP) activation in the ED; National Institutes of Health Stroke Scale (NIHSS) score at presentation; final diagnosis upon hospital discharge; administration of intravenous rt-PA; and utilization of endovascular intervention. Last known well time was recorded in hours and rounded to the nearest 15 minutes. ASP activation was directed by the ED physician if the patient presentation was consistent with an acute stroke, which was determined by review of the Neurology consultation note and ED physician note. NIHSS score at presentation, use of rt-PA, and endovascular intervention were recorded based on review of neurology consultation note and hospital admission note. Final diagnosis at discharge was documented based on review of hospital admission note and discharge summary.

Inclusion criteria included any one of the following: (1) positive CPSS in field; (2) EMS impression of CVA or TIA; (3) ASP activation in the ED; or (4) discharge diagnosis of CVA or TIA. Exclusion criteria included any one of the following: (1) hospital arrival via helicopter; (2) outside hospital transfer; (3) direct admission without ED evaluation; or (4) last known well time greater than 6 hours.

Data were subsequently organized into continuous and categorical variables. Categorical variables were described as proportions, expressed as a percent of total. Continuous variables were all summarized based on mean, median, standard deviation, and interquartile range. A