

A Geographic Information System Analysis of the Impact of a Statewide Acute Stroke Emergency Medical Services Routing Protocol on Community Hospital Bypass

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Background: Our goal was to determine if a statewide Emergency Medical Services (EMSs) Stroke Triage and Destination Plan (STDP), specifying bypass of hospitals unable to routinely treat stroke patients with thrombolytics (community hospitals), changed bypass frequency of those hospitals. *Methods:* Using a statewide EMS database, we identified stroke patients eligible for community hospital bypass and compared bypass frequency 1-year before and after STDP implementation. *Results:* Symptom onset time was missing for 48% of pre-STDP (n = 2385) and 29% of post-STDP (n = 1612) cases. Of the remaining cases with geocodable scene addresses, 58% (1301) in the pre-STDP group and 61% (2,078) in the post-STDP group were ineligible for bypass, because a community hospital was not the closest hospital to the stroke event location. Because of missing data records for some EMS agencies in 1 or both study periods, we included EMS agencies from only 49 of 100 North Carolina counties in our analysis. Additionally, we found conflicting hospital classifications by different EMS agencies for 35% of all hospitals (n = 38 of 108). Given these limitations, we found similar community hospital bypass rates before and after STDP implementation (64%, n = 332 of 520 vs. 63%, n = 345 of 552; $P = .65$). *Conclusions:* Missing symptom duration time and data records in our state's EMS data system, along with conflicting hospital classifications between EMS agencies limit the ability to study statewide stroke routing protocols. Bypass policies may apply to a minority of patients because a community hospital is not the closest hospital to most stroke events. Given these limitations, we found no difference in community hospital bypass rates after implementation of the STDP. **Key Words:** EMS—stroke—transport—bypass—protocols.

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Introduction

Reperfusion therapy and other advances in acute stroke management over the past 2 decades highlight the critical role of emergency medical services (EMSs) in optimizing acute stroke care.¹⁻⁵ Most importantly, early administration of intravenous (IV) tissue plasminogen activator (tPA) increases the likelihood of benefit, especially within 90 minutes from symptom onset.^{3,6-8} EMS protocols, which route patients to hospitals best prepared to administer IV-tPA is 1 strategy to improve timely utilization of thrombolytic therapy for acute stroke patients.^{1,9-12}

The American Stroke Association (ASA) recommends that all stroke patients be transported to the nearest Joint Commission (JC) primary stroke center (PSC) or hospital with an equivalent designation.¹³ Based on that recommendation, in 2008 we evaluated the location of PSCs in North Carolina (NC) relative to the resident addresses of patients who died from stroke and found that only 56% of stroke victims resided within a 40-minute drive to a PSC.¹⁴ We also found many NC counties with the heaviest burden of stroke mortality were beyond practical drive-time areas to a PSC.¹⁵ Those findings supported enhancing access to acute stroke treatment in NC, beyond that simply afforded by PSCs, via a 3-tiered hospital classification system. In 2010, the North Carolina Office of Emergency Medical Services (NCOEMS) integrated such a system into a prehospital Stroke Triage and Destination Plan (STDP). That plan classifies lowest tier hospitals ("Community Hospitals") as those without the capability to routinely administer IV-tPA and specifies that EMS providers should bypass these facilities, within certain time constraints, to transport acute stroke patients directly to a hospital that can more consistently offer fibrinolysis. As of 2010, similar EMS routing to state designated stroke centers existed in at least 15 other states,¹⁰ yet the adherence to and overall impact of such protocols is unknown.^{1,12}

Our objective was to investigate implementation of its STDP using a large statewide EMS database and combining a geographic information system (GIS) drive time analysis with traditional analytic methods. Accordingly, our main goal was to determine if the STDP changed the frequency of community hospital bypass by EMS when transporting patients with a prehospital impression of acute stroke. Our secondary goals included determining if EMS transport times changed after STDP implementation, and because the STDP specifies that EMS on-scene time should be minimized to less than or equal to 10 minutes, determining if the proportion of patients with an on-scene time of less than or equal to 10 minutes changed after STDP implementation.

Materials and Methods

Study Design and Setting

We conducted a statewide study in NC comparing 1-year periods before and after STDP implementation, which occurred on January 1, 2010. As of that date, the NCOEMS required every EMS agency in NC to implement their local version of the STDP based on an established template (Fig 1). To examine the period before STDP implementation, we used data from January 1 to December 31, 2009. For the period after STDP implementation, we used data from April 1, 2010 to March 31, 2011, excluding the first quarter of 2010 as a transition period. The Carolinas Medical Center Institutional Review Board approved this study.

The STDP instructs each EMS agency to classify hospitals in their transport region into 1 of 3 categories. "Primary Stroke Centers" are hospitals holding accreditation by the JC as PSCs. "Stroke Capable Hospitals" (SCH) are those with processes and systems in place to routinely administer IV-tPA. All other hospitals within the EMS System's service area receiving ambulance patients are classified as "Community Hospitals." Individual EMS agencies were responsible for categorizing hospitals in their STDP. Except for PSCs, there was no certified process to assess and categorize hospitals' stroke care capabilities; therefore, there was a potential for a given hospital to be categorized differently by different EMS agencies. Our analysis found that 35% of all hospitals (n = 38 of 108) had conflicting categorizations by different EMS agencies. In cases where hospitals had differing classifications, we used the hospital classification of the transporting EMS agency. The STDP recommends transport of patients with symptoms of acute stroke to a PSC or SCH, bypassing a community hospital if necessary, when the estimated time from symptom onset to hospital arrival can be less than 2 hours and transport time will not exceed 50 minutes. EMS agencies had the option of changing either of the times specified in the STDP template. For the few EMS agencies that did alter these times, we adjusted study time analyses to reflect the transporting EMS agency's STDP.

Data Sources

We used Prehospital Medical Information System (PreMIS), which is an internet-based system for documenting EMS service delivery and care for patients in NC.¹⁶ EMS agencies collect and submit data into PreMIS using either a web-based interface provided at no cost or a commercial EMS data system certified compliant for all data elements required by the NCOEMS.¹⁶ In 2008, 42% of the EMS agencies entered 17% of the total records in PreMIS through the web-based interface.¹⁶

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