Original Contribution

Estimated Impact of Emergency Medical Service Triage of Stroke Patients on Comprehensive Stroke Centers

An Urban Population-Based Study

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Background and Purpose—The American Stroke Association recommends that Emergency Medical Service bypass acute stroke–ready hospital (ASRH)/primary stroke center (PSC) for comprehensive stroke centers (CSCs) when transporting appropriate stroke patients, if the additional travel time is ≤15 minutes. However, data on additional transport time and the effect on hospital census remain unknown.

Methods—Stroke patients ≥20 years old who were transported from home to an ASRH/PSC or CSC via Emergency Medical Service in 2010 were identified in the Greater Cincinnati area population of 1.3 million. Addresses of all patients' residences and hospitals were geocoded, and estimated travel times were calculated. We estimated the mean differences between the travel time for patients taken to an ASRH/PSC and the theoretical time had they been transported directly to the region's CSC.

Results—Of 929 patients with geocoded addresses, 806 were transported via Emergency Medical Service directly to an ASRH/PSC. Mean additional travel time of direct transport to the CSC, compared with transport to an ASRH/PSC, was 7.9±6.8 minutes; 85% would have ≤15 minutes added transport time. Triage of all stroke patients to the CSC would have added 727 patients to the CSC's census in 2010. Limiting triage to the CSC to patients with National Institutes of Health Stroke Scale score of ≥10 within 6 hours of onset would have added 116 patients (2.2 per week) to the CSC's annual census.

Conclusions—Emergency Medical Service triage to CSCs based on stroke severity and symptom duration may be feasible. The impact on stroke systems of care and patient outcomes remains to be determined and requires prospective evaluation. **(*Stroke*. 2017;48:00-00. DOI: 10.1161/STROKEAHA.116.015971.)**

Key Words: Emergency Medical Services ■ hospitals ■ stroke ■ triage

Intravenous tPA (tissue-type plasminogen activator) and endovascular therapy are time-sensitive treatments for acute ischemic stroke (AIS).[1,2] Likelihood of a good functional outcome decreases by 3% to 4% for every 15-minute delay in starting tPA treatment[3] and by 12% for every 30-minute delay in recanalization by endovascular therapy.[2] Because patients with large vessel occlusions (LVOs) have better outcomes with endovascular therapy,[4] preferential triage of severe AIS patients with a high likelihood of LVO to comprehensive stroke centers (CSCs) that can deliver endovascular therapy is desirable, unless the delay to the initiation of any reperfusion therapy is too long. Stroke systems of care are recommended to provide rapid access to endovascular therapy equitably to all eligible patients.[5]

Emergency Medical Service (EMS) providers are the first medical contact for half of all stroke patients,[6] and EMS is used more frequently in patients with more severe neurological deficits.[7] Examination scales have been created to aid EMS personnel in the identification of strokes and severe strokes in the prehospital setting.[8–13] After identification of potential

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stroke patients, EMS providers are responsible for triaging patients to the appropriate hospital and level of care. One potential modification of the current stroke triage system is to have EMS transport all suspected stroke patients directly to a CSC rather than to a closer acute stroke–ready hospital (ASRH) or primary stroke center (PSC),[5,9,14,15] but unnecessary overtriage may delay time to treatment for the individual patient,[1] while contributing to emergency department (ED) overcrowding and its known adverse impact on patient outcomes.[16]

Bypassing an ASRH/PSC for a CSC for appropriate stroke patients has been recommended by the American Stroke Association as long as the extra transportation time is no >15 to 20 minutes.[14] Current recommendations do not describe which subgroups of patients should be brought directly to a CSC. Using EMS to identify severe stroke using the National Institutes of Health Stroke Scale (NIHSS) or a shorter clinical scale such as the Cincinnati Stroke Triage Assessment Tool (formally referred as Cincinnati Prehospital Stroke Severity Scale)[9,11–13] for triage to CSCs has been previously proposed.[5,9,14,15]

We analyzed the potential effect of preferential EMS triage of stroke patients to a CSC instead of an ASRH/PSC on transportation times and the diverting and receiving hospital census within the metropolitan area of the Greater Cincinnati Northern Kentucky population of 1.3 million.

Methods

The GCNKSS (Greater Cincinnati/Northern Kentucky Stroke Study) is a primarily urban population-based study of temporal trends in stroke incidence in a biracial population of 1.3 million. The 5-county geographic region includes 15 regional hospitals and has a population density of 967 people per square mile. Details of the study's methodology are described elsewhere.[17] Briefly, the GCNKSS retrospectively identified all transient ischemic attack (TIA), AIS, intracerebral hemorrhage, and subarachnoid hemorrhage patients among residents of the region in calendar year 2010 by screening International Classification of Diseases–Ninth Revision codes 430 to 436. Trained research nurses abstracted information from hospital charts related to the acute stroke events, and study physicians verified stroke cases and determined stroke subtype. The Institutional Review Boards at all participating hospitals approved the study.

Each hospital in the Greater Cincinnati/Northern Kentucky (GCNK) region was defined as a CSC, PSC, or ASRH hospitals for study purposes based on how the hospital would be designated under 2015 Joint Certification stroke certification standards. The CSC designation was not available in 2010, but 1 hospital earned CSC status in 2013, and it remains the only CSC in the GCNK region. Thus, this hospital was defined as a CSC for our analysis. Of the remaining 14 hospitals, 3 were certified as PSCs in 2010, and the remainder were designated ASRH (Figure 1).

The present analysis included all AIS, intracerebral hemorrhage, and subarachnoid hemorrhage stroke patients ≥20 years of age who were transported by EMS from the patient's primary residence to one of the area hospital's EDs. TIA patients were excluded. The following data items were extracted from hospital records for the current analysis: time of symptom onset, address of the patient's residence, address of the ED of presentation, time of arrival at the ED, and initial NIHSS determined retrospectively (rNIHSS).[18,19] If symptom onset was witnessed, the exact time of onset was recorded. If not witnessed, the time last seen normal was used. Otherwise, timing of onset was estimated in 1 of 4 6-hour time windows—after midnight (00:01–06:00), morning (06:01–12:00), afternoon (12:01–18:00), or evening (18:01–midnight). Wake-up strokes and cases for which presentation was >24 hours after onset were separately classified.

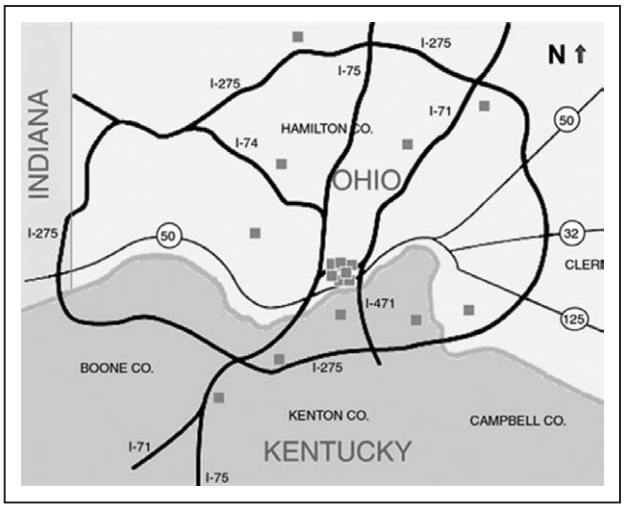

Figure 1. Geographic distribution of the 15 hospitals in the GCNKSS (Greater Cincinnati/Northern Kentucky Stroke Study) region.

Also recorded was whether patients who were initially transported to an ASRH/PSC were subsequently transferred to the area's CSC. Home and hospital addresses were geocoded with US Census Geocoder (US Census Bureau 2014) to obtain longitude and latitude coordinates, and travel time was estimated using road class speed limits for the route with the shortest driving time to both the presenting hospital and the CSC. Travel times were computed using ArcGIS geographic information systems software (Esri 2015), and the North American road network data were prepared by TomTom 2013.

We used descriptive statistics to summarize estimated transport times to the initial presenting hospital, as well as the difference between the travel time to the ASRH/PSC and the travel time it would have taken if the patient had been transported directly to the CSC (for those who initially presented to an ASRH/PSC).

To measure the potential effect of direct transport to the CSC on ASRH/PSC and CSC volume, including the potential range of CSC volume changes using estimated times, we further classified patients into the following subgroups: wake-up strokes, patients who presented within 3, 4.5, 6, and 12 hours of onset. For patients with estimated onset times, time from onset to ED arrival was calculated based on earliest time of the window (eg, 00:01 for after midnight). Analysis was also performed on the subset of patients in each subgroup with moderate or severe stroke (rNIHSS score of ≥10).[9]

Results

There were 2720 hospitalized stroke patients who were ≥20 years old among residents of the GCNK study region during calendar year 2010. Of the 1102 (40.5%) who used EMS, 937 were transported by EMS directly to an area hospital from the patient's residence, and 929 residence addresses were successfully geocoded and were included in the analyses. The majority of stroke patients (806/929 [87%]) were transported to an ASRH/PSC; the remaining 123 (13%) presented to the CSC. An additional 79 patients underwent secondary transfer from a PSC/ASRH to the CSC.

Among the 929, witnessed onset time was documented for 344, last known normal was documented for 108, onset time was estimated in 6-hour time windows for 150, 176 had wake-up strokes, and 151 presented beyond 24 hours of onset. Among the 753 strokes not classified as wake-up and using the earliest time for strokes with an estimated time range, 319 (42%) arrived at the ED within 3 hours of symptom onset, 378