ACCURACY OF STROKE RECOGNITION BY EMERGENCY MEDICAL DISPATCHERS AND PARAMEDICS—SAN DIEGO EXPERIENCE

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ABSTRACT

Background. Prehospital personnel in Emergency Medical Service (EMS) systems have varying levels of accuracy in stroke recognition. Identifying the accuracy of emergency medical dispatcher using Medical Priority Dispatch Systems (MPDS) stroke protocol and paramedics may help understand the accuracy of stroke recognition in about 3000 emergency medical dispatch systems and prehospital systems worldwide. Objective. Our aim was to assess the accuracy of stroke identification in emergency medical dispatchers (EMD) with high compliance to MPDS protocol and paramedics using Cincinnati Prehospital Stroke Scale (CSS). Methods. This was a retrospective observational study. Data was acquired from a computer assisted dispatch (CAD) system, a computerized paramedic record database and discharge diagnosis from billing records or stroke registry containing all stroke assessments of patients who presented to the participating study hospitals within 12 hours of symptom onset. We included patients 18 years or older, identified as having stroke by EMD and city agency paramedics. We excluded patients taken to hospitals not participating in the study, patients with a dispatch determinant of Stroke (card 28) not transported by City EMS agency (SDMSE) to participating hospitals, patients in the stroke registry not transported by SDMSE or patients with no final outcome data. A stroke neurologist or hospital discharge diagnosis of stroke (physician diagnosis) was used to determine the sensitivity and predictive values of EMD and paramedic recognition of stroke. Results. Of 832 patients with a dispatch determinant of stroke using MPDS Stroke protocol, 367 had a final discharge diagnosis of stroke. This gives a sensitivity of 83% and a positive predictive value of 42% for EMD using MPDS Stroke protocol. Of 477 patients with a paramedic assessment of stroke using CSS, 193 had a final discharge diagnosis of stroke. This gives a sensitivity of 44% and a PPV of 40% for paramedics using CSS. Conclusions. In our EMS system, EMD using MPDS Stroke protocol with a high compliance has a higher sensitivity than paramedics using CSS. Key words: cerebrovascular accident; emergency medical services; neurologic manifestations.

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BACKGROUND AND PURPOSE OF THE STUDY

In this era of thrombolysis and revascularization procedures, management of acute ischemic stroke is a time-critical process. Even though majority of the delays have been attributed to patient access of emergency healthcare, it is important for prehospital and hospital systems to respond quickly and efficiently to improve outcomes for patients with acute stroke. In prehospital systems, stroke recognition is achieved by both emergency medical dispatchers (EMD) and field providers.

EMD plays a vital role within emergency medical services (EMS) systems, as they are the first point of medical contact in an emergency response system. Roles of emergency medical dispatchers include recognition of stroke symptoms, assignment of an appropriate ambulance response for each patient and provision of post-dispatch instructions based on individual requirements. It is crucial for them to identify stroke to avoid inappropriate assignment of low acuity code and thereby reduce delays in ambulance response. It is also important for EMD to be highly sensitive in stroke recognition and also fairly specific to avoid overutilization of EMS resources. Further, in the future, once stroke is recognized, EMD can be trained to notify emergency departments to expedite stroke triage and notification of stroke teams for acute management.

Like prehospital stroke scales, dispatch programs contain protocols to guide emergency medical dispatcher recognition of stroke and appropriate ambulance response assignment. The most widely used dispatch program is the Medical Priority Dispatch System (MPDS). Although 3000 cities across the world use MPDS, only 80 agencies (2%) are recognized as accredited centers of excellence, defined as having high dispatcher compliance (>90%), education programs, protocol review, field training and medical
direction. While prior studies have reported varying levels of dispatch recognition and priority assignments by emergency medical dispatchers using MPDS, there is paucity of studies on validation of MPDS protocol for stroke and comparison of medical dispatcher and paramedic recognition of stroke within the same system.

The role of field prehospital providers i.e. paramedics, include recognition of signs and symptoms of stroke, triage of patients to primary or specialized stroke centers, initiation of clinical trial treatment protocols in special circumstances and notification of emergency department about the impending patient arrival. The various prehospital stroke scales available for use by EMS systems include Cincinnati Prehospital Stroke Scale (CSS), Los Angeles Prehospital Stroke Screen (LAPSS), Melbourne Ambulance Stroke Screen (MASS) and Face Arm Speech Test (FAST). Although the various stroke scales have been validated in prior studies, our study is unique in comparing the accuracy of EMD and paramedics within a single EMS system using the discharge diagnosis of stroke.

The purpose of the study was to determine the accuracy of EMD and paramedic recognition of stroke. Since our EMD have a high compliance to the protocol, this study will help to determine the sensitivity of the MPDS Stroke protocol. By assessing the accuracy of EMD and paramedics, deficiencies in prehospital stroke recognition can be identified. This will pave way for future studies to determine factors that could further improve the accuracy of stroke recognition by prehospital providers.

**SUBJECT AND METHODS**

This is a retrospective observational study and was conducted in the EMS system of the City of San Diego during the time period January 1, 2005 to December 31, 2005. Using a descriptive study design we wanted to determine the accuracy of EMD using MPDS stroke protocol and paramedics using CSS by comparing the dispatch determinant code and paramedic clinical assessment to a stroke team diagnosis or hospital discharge diagnosis. The participating sites included the Fire Communication Center of the City of San Diego (FCC), San Diego Medical Service Enterprise (SDMSE) and six hospitals in the County of San Diego. This study protocol was approved by the Institutional Review Boards (IRB) of all participating institutions and was granted waiver of informed consent.

San Diego County is the sixth largest county in the US and has a population of approximately 3 million residing in 4000 square miles. There are 18 acute care hospitals serving the San Diego County region. The age-adjusted rate of hospitalization for stroke in San Diego County is 3.04 per 1000.

The City of San Diego has a population of 1.3 million and is the eighth largest city in the Country. The Fire Communication Center for the City of San Diego receives about 100,000 medical aid calls annually. Advanced life support response in the City of San Diego consists of a fire department engine based paramedic as well as a paramedic staffed ambulance.

**EMS System in City of San Diego**

The City of San Diego FCC is staffed with approximately 33 full time emergency medical dispatchers who are trained according to the California EMS Authority guidelines. They also undergo a refresher course on stroke annually. In addition, EMD in FCC have completed the 20-point requirement by National Association of Emergency Medical Dispatch (NAEMD) and FCC has remained a center of excellence from 1998 through the study period. In a center of excellence, EMD have more than 90% compliance with the MPDS protocols including stroke protocol making it feasible to study the accuracy of the MPDS Stroke protocol.

The dispatch center uses the computerized version of the MPDS protocols called Pro QA. Pro QA (MPDS Version 11.2, Priority Dispatch Corp.) is a state-of-the-art emergency medical dispatching Windows-NT based software program that integrates with computer assisted database (CAD) and phone systems. Pro QA guides the emergency medical dispatcher through a series of scripted questions to determine the acuity of patient status and select the case entry protocol specific to the chief compliant for e.g. stroke. Using Pro QA, emergency medical dispatchers ask a standardized series of questions (MPDS protocol) and based on the caller responses assign a determinant code. The caller information, determinant code and other call related data are captured in the Pro QA. The compliance to the MPDS Stroke protocol is captured in the performance reports generated by the software AQUA used by quality management staff to monitor individual and center performance.

San Diego Medical Service Enterprise (SDMSE) is the largest 911 paramedic and non-emergency provider for residents in the County of San Diego. In addition to serving the City of San Diego, they also serve a specific geographical County service area and also provide non-emergency transport to three hospital groups in the County of San Diego. The participating EMS agency, San Diego Medical Service Enterprise (SDMSE) has 450 paramedics and 800 first responders. Each year, City of San Diego paramedics receive one hour of formal instruction in the recognition and management of acute stroke from the City Medical Director (JD). Medics are taught time-critical aspects of early stroke care, the differential diagnosis of stroke and development of a regional stroke system in San Diego.
The San Diego County Division of Emergency Medical Services Policy S-123 addresses “Altered Neurological Function, Nontraumatic.” Paramedics employ the Cincinnati Prehospital Stroke Scale to assess for facial droop, arm drift and speech abnormality. For suspected stroke occurring within 2 hours of onset medics are advised to expedite transport and provide early notification to the on-line base hospital to confirm destination. At the time of this study, stroke receiving centers were not formally designated, patient destination request was honored and lack of availability of CT was the primary indication for ED diversion for suspected acute stroke. At the conclusion of each paramedic transport, paramedics generate a Palm-based electronic medical record called “TapCharts” which includes chief complaint, medical interventions, diagnostic codes and ambulance destination. This information is uploaded to a computer server maintained by SDMSE.

**Study Site Hospitals (Table 1)**

The County of San Diego has 18 acute care hospitals. The six participating hospitals include the two campuses of the academic medical center and four community hospitals with access to stroke team neurologists based at the academic medical center. The two campuses of the academic medical center were the only JCAHO certified stroke centers among the six hospitals during the study period. The volume of patients seen in the emergency departments at the academic medical centers is approximately 70,000 and the total number of EMS transports to these hospitals annually are about 8500 (12% of total ED visits). The number of annual emergency department visits to the community hospitals is about 177,000 and the number of transports by the city EMS agency to these hospitals is approximately 23,000 (13% of total ED visits). The number of stroke transports based on the field diagnosis by paramedics to the academic medical centers during the study period was 95 and the number of stroke transports by paramedics to the community hospitals during the study period was 398.

**TABLE 1. Characteristics of Participating Hospitals in the City of San Diego during the Year 2005**

<table>
<thead>
<tr>
<th>Type of Hospital</th>
<th>Total number of ED Visits</th>
<th>Total number of EMS transports</th>
<th>Transports with paramedic assessment of stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic/University</td>
<td>50,000</td>
<td>7453</td>
<td>81</td>
</tr>
<tr>
<td>affiliated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic/University</td>
<td>20,000</td>
<td>1168</td>
<td>14</td>
</tr>
<tr>
<td>affiliated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td>70,000</td>
<td>8825</td>
<td>170</td>
</tr>
<tr>
<td>Community</td>
<td>55,000</td>
<td>12324</td>
<td>180</td>
</tr>
<tr>
<td>Community</td>
<td>22,000</td>
<td>2229</td>
<td>46</td>
</tr>
<tr>
<td>VA Hospital</td>
<td>30,000</td>
<td>224</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>247,000</td>
<td>32223</td>
<td>493</td>
</tr>
</tbody>
</table>

**Subjects**

Our inclusion criteria for the study were patients who are 18 years or older identified as having stroke in the prehospital phase using the MPDS Stroke protocol by emergency medical dispatchers or by use of CSS by paramedics. Although, young adults and children do suffer stroke, it was arbitrarily determined that we would study patients over 18 years of age only. Patients who were taken to other acute care hospitals not participating in the study, patients with a dispatch determinant of Stroke (card 28) who were not transported by City EMS agency (SDMSE) to participating hospitals, patients in the stroke registry not transported by SDMSE or patients with no final outcome data were excluded from the study.

**Data Collection**

Data was collected from prehospital resources called the Computer Assisted Dispatch (CAD) database at the FCC and the computerized paramedic records called “Tapcharts.” The source for outcome data is the stroke registry maintained by the stroke team at the academic medical center and the billing records of the participating hospitals if outcome was not available in the stroke registry. During the study period, we acquired the number of medical aid calls to the FCC, the total number of patients with a stroke determinant code (Card 28), compliance of emergency medical dispatchers to the MPDS Stroke protocol and patient demographics from the CAD. We obtained clinical assessment of paramedics using Cincinnati Prehospital Stroke Scale, time spent on scene, time to destination, and hospital destination and patient demographics from the computerized paramedic database maintained by SDMSE. The stroke registry database had patient demographics, adjudicated final diagnosis for each patient while the hospital billing records had patient demographics and ICD-9 codes for the patient’s hospital visit. [Transient Cerebral Ischemia Unspecified, Cerebral Artery Occlusion Unspecified with Cerebral Infarction, Intracranial Hemorrhage Unspecified or other related ICD 9 codes 430–438].

Once the data from all sources were collected, we used the transport identification number from the tapcharts to directly link the two prehospital databases i.e. CAD and Tapcharts. The transport number is unique to each individual call and related patient transport. Once the prehospital databases were linked, we matched this dataset with the stroke registry and billing records using patient information. The discharge diagnosis for patients in stroke registry was compared with patients who had a prehospital diagnosis of stroke.
Data Analysis

We classified true positive strokes as patients who were assigned a code of determinant stroke by emergency medical dispatchers or paramedics and had a discharge diagnosis of stroke. False negatives were patients with a discharge diagnosis of stroke from the stroke registry with no dispatch determinant or paramedic diagnosis of stroke. False positives are patients with dispatch determinant or paramedic diagnosis of stroke with a discharge diagnosis other than stroke. We were not able to obtain true negatives since we did not follow all patients with a dispatch determinant or paramedic diagnoses other than stroke. Data from all three databases were entered into MS Access 2003 (Microsoft Corp., Redmond, WA) and analyzed using SPSS Version 14 (SPSS Inc., Chicago, IL).

RESULTS

A total of 86,989 medical aid calls were received at the FCC during the 12 month study period. The total number of EMS transports for the year by SDMSE was 72,638. Of all the medical aid calls, the total number of stroke determinant codes by the emergency medical dispatchers for the study period was 2140 (2%). Of the 72,638 EMS transports by SDMSE, the total number of paramedic assessment of stroke using CSS was 995 (1.3%). The numbers of patients with a dispatch determinant of stroke transported by SDMSE to the six participating hospitals were 882 and the numbers of patients with positive CSS assessments transported by SDMSE to the six participating hospitals were 493. The total numbers of patients in the stroke registry included in our study were 440.

* Missing data 16

**FIGURE 1.** Number of patients with prehospital recognition of stroke taken to the participating hospitals in San Diego during the year 2005.
The numbers of patients with missing data were 16 (Figure 1).

**Dispatcher Diagnostic Accuracy: (Table 2)**

Among all stroke patients taken to the study hospitals, EMD assigned a determinant code of Stroke to 882 patients. Of the 882 patients, only 367 (42%) had a final diagnosis of stroke. Therefore, the numbers of true positive strokes were 367. Emergency medical dispatchers did not assign a dispatch determinant to 73 patients who had a final diagnosis of stroke in the registry. Therefore, the numbers of false negative strokes were 73. The sensitivity and positive predictive value for EMD using MPDS Stroke protocol is 83% (95 CI 80–87), and 42% (95 CI 37–46) respectively.

**Paramedic Diagnostic Accuracy: (Table 2)**

City paramedics using the CSS determined 493 transports to be strokes of which final outcome data was available for 477. Of the 477, 193 (40%) had a final diagnosis of stroke. Therefore, the numbers of true positives were 193. Paramedics did not recognize 247 patients with a final diagnosis of stroke. Therefore the numbers of false negative strokes were 247. The sensitivity and positive predictive value for paramedics using CSS for stroke recognition in our EMS system with 95% CI are 44% (95 CI 39–49), and 40% (95 CI 36–45) respectively.

**DISCUSSION**

Accurate recognition of stroke by EMD is important because ambulance response, field communication and allocation of field resources are based on determinant code assigned by emergency medical dispatchers. Although this may be less important in urban single tier systems with high priority response and short response time to potential stroke calls, this may carry more significance in multi-tiered, rural or volunteer systems. Therefore, in order to have a universal robust dispatch system that recognizes most stroke patients accurately as well as appropriately assign priority responses, it is imperative to study the accuracy of the protocols used by EMD and also to study various factors that improve recognition of stroke by EMD.

Prior studies have examined the accuracy of stroke recognition by emergency medical dispatcher, communication of stroke symptoms by callers to medical dispatchers as well as the response assignment of dispatchers in these situations. Such studies have shown varying levels of emergency medical dispatch recognition as well as response assignments to callers with possible stroke. Porteous et al. reported that emergency medical dispatchers coded less than half of the calls as stroke when the caller used the term “stroke” and only 41% of ambulance assignments for stroke were high priority responses. As one of the early studies on stroke recognition by prehospital providers, the authors reported the dispatcher sensitivity for stroke, but did not report accuracy of the MPDS stroke protocol. Following this study, Ellison and co-investigators reported a sensitivity of 61% and a specificity of 20% for stroke recognition by emergency medical dispatchers. While the medical dispatchers in the latter study used MPDS protocols they did not report a high compliance to the protocol. Rosamond et al. in their study on understanding how stroke symptoms are been communicated to dispatchers reported that only 31% of patients discharged with a diagnosis of stroke/TIA were assigned a dispatch determinant of stroke in centers using MPDS protocols. In our study, we determined the

**TABLE 2. Accuracy of Stroke Recognition by Emergency Medical Dispatchers and Paramedics in City of San Diego during the year 2005.**

<table>
<thead>
<tr>
<th>Diagnosis of Stroke by Emergency Medical Dispatchers (EMD)</th>
<th>Yes</th>
<th>No</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>367</td>
<td>515</td>
<td>882</td>
</tr>
<tr>
<td>No</td>
<td>73</td>
<td>90</td>
<td>163</td>
</tr>
<tr>
<td>TOTAL</td>
<td>440</td>
<td>605</td>
<td>1045</td>
</tr>
<tr>
<td>Sensitivity of stroke recognition</td>
<td>83%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnosis of Stroke by Paramedics</th>
<th>Yes</th>
<th>No</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>193</td>
<td>284</td>
<td>477</td>
</tr>
<tr>
<td>No</td>
<td>247</td>
<td>321</td>
<td>568</td>
</tr>
<tr>
<td>TOTAL</td>
<td>440</td>
<td>605</td>
<td>1045</td>
</tr>
<tr>
<td>Positive Predictive Value of stroke recognition</td>
<td>44%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

True Positive—Patients with EMD determinant or paramedic assessment of stroke and discharge diagnosis of stroke
False Negative—Patients with EMD determinant or paramedic assessment other than stroke and a discharge diagnosis of stroke
False Positive—Patients with EMD determinant or paramedic assessment of stroke and a discharge diagnosis other than stroke.

* Sensitivity of stroke recognition = True Positive/ True Positive+ False Negative
* Positive Predictive Value of stroke recognition = True Positive/True Positive+ False Positive
Speci city and Negative Predictive values not calculated in this study.
accuracy of emergency medical dispatchers with a high compliance to the MPDS stroke protocols and our results showed high sensitivity (85%) and moderate positive predictive value (42%) for stroke recognition. It is likely that this difference in sensitivity maybe from low number of false negatives in our study sample. Many of the subtle presentations of strokes may have been missed by EMD and since we did not obtain final diagnosis on all medical aid calls, our sensitivity values may appear higher than in the previous studies. Also, higher sensitivity maybe a result of increase in knowledge about stroke among our EMD thereby, leading to better stroke recognition. Even though in our discussion we state that training may be an important factor in stroke recognition, a better understanding of the training factor and its role in EMD recognition of stroke should be achieved through future studies. Recent studies by Hurwitz et al and Liferidge et al reported that laypersons or untrained adults could administer the CSS to patients and return the findings to the investigator successfully when directed by simulated dispatchers.22,23 The use of such novel strategies may further help to improve dispatch recognition of stroke and expedite stroke triage in the prehospital setting.

Paramedics play an important role in the recognition, triage, expedited transport and management of stroke patients. In our study, we noted the sensitivity of paramedics for stroke recognition is about 44% and a positive predictive value of 40%. Smith and colleagues reported a higher sensitivity (61%) and positive predictive value (77%) among paramedics not using prehospital stroke scales.24 Also, during the validation phase of the Cincinnati Stroke Scale, paramedic sensitivity of 59% was higher than values reported in our study.25 Bray and colleagues reported a sensitivity of 78% among paramedics in their system and showed an increase in sensitivity among paramedics after educational session and use of a stroke scale.26,27 Wojner-Alexandrov and colleagues reported increase in sensitivity for paramedics after use of Los Angeles Prehospital Stroke Screen (LAPSS) and monthly paramedic education.28 The reasons for low sensitivity among our paramedics may be multi-factorial. Paramedics may have coded stroke symptoms as “Altered Neurological Function” but, this was not included in our database. This may underestimate the number of true positive strokes or increase the number of false negatives leading to lower sensitivity for paramedic recognition. Although, missing data from paramedic records were captured in the study but we did not screen for documentation errors in paramedic charts which may have contributed to less accurate estimate of sensitivity and predictive value. Even though paramedics use the Cincinnati Stroke Scale, we did not assess the knowledge or variability among the providers during the study period. It has been shown in prior studies that paramedic education improves stroke recognition and therefore, our paramedics receive a refresher course on stroke. However, the duration of knowledge retention and frequency for training sessions have not been established and may be an area of future study.

**Limitations**

Although we have taken steps to ensure reliable data extraction from the various databases, a number of inherent limitations of retrospective study design must be noted. In a retrospective study, data is not primarily collected for study purposes and therefore, one of the limitations includes lack of completeness of databases. Emergency Medical Dispatchers and field providers may not always record their assessments leading to missing data fields. However, in our study sample we found only a small number of missing data due to electronic data collection thereby minimizing the impact of missing data on study results. A major limitation resulting from the retrospective nature of the study is that we did not follow all medical aid calls to determine the outcomes. This was due to the large volume of calls received at the FCC and inability to follow patients transported by multiple EMS agencies to different destinations across the county, with the limited research resources. Hence, we could not reliably obtain the population of true negatives. Therefore, we were unable to calculate the specificity and negative predictive values of the MPDS stroke protocol and Cincinnati Prehospital Stroke Screen in our system. The calculation of emergency medical dispatcher or paramedic sensitivity is somewhat limited since false negatives were defined as patients with a stroke registry diagnosis of stroke and prehospital diagnosis other than stroke. The results may be more accurate if we also followed all patients with prehospital diagnoses other than stroke. However, as stated above, this was not feasible with the resources and datasets available for the research study.

Further limitations include restricted generalizability of the study results to non-urban EMS agencies. However, if the compliance of the emergency medical dispatchers to the MPDS Stroke protocol is known to be high as in our system, the accuracy of the stroke recognition in any EMS system may be similar to our results. While compliance to dispatch protocols is known, there is no measure of paramedic compliance or variability among our paramedics in our EMS system. Hence, we can only conclude about the accuracy of paramedics using the Cincinnati Prehospital Stroke Scale and not validate the Cincinnati Prehospital Stroke Scale using this retrospective study design. Lastly, while the stroke team adjudicated the stroke team diagnosis, we cannot comment on the validity of the ICD-9 codes or hospital discharge diagnosis for patients not included in the stroke registry. However, due to lack of other outcome data, they serve as the gold standard for determining prehospital accuracy of stroke recognition.
**CONCLUSIONS**

Emergency Medical Dispatchers have a high sensitivity for stroke recognition in our system but both EMD and paramedics have similar positive predictive value for stroke recognition.

**References**


