Determinants of Use of Emergency Medical Services in a Population With Stroke Symptoms

The Second Delay in Accessing Stroke Healthcare (DASH II) Study

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**Background and Purpose**—With the advent of time-dependent thrombolytic therapy for ischemic stroke, it has become increasingly important for stroke patients to arrive at the hospital quickly. This study investigates the association between the use of emergency medical services (EMS) and delay time among individuals with stroke symptoms and examines the predictors of EMS use.

**Methods**—The Second Delay in Accessing Stroke Healthcare Study (DASH II) was a prospective study of 617 individuals arriving at emergency departments in Denver, Colo, Chapel Hill, NC, and Greenville, SC, with stroke symptoms.

**Results**—EMS use was associated with decreased prehospital and in-hospital delay. Those who used EMS had a median prehospital delay time of 2.85 hours compared with 4.03 hours for those who did not use EMS ($P=0.002$). Older individuals were more likely to use EMS (odds ratio [OR] 1.21 for each 5-year increase, 95% CI 1.14 to 1.29), as were individuals who expressed a high sense of urgency about their symptoms (OR 1.69, 95% CI 1.09 to 2.62). Knowledge of stroke symptoms was not associated with increased EMS use (OR 0.63, 95% CI 0.40 to 0.98). Patients were more likely to use EMS if someone other than the patient first identified that there was a problem (OR 2.35, 95% CI 1.61 to 3.44).

**Conclusions**—Interventions aimed at increasing EMS use among stroke patients need to stress the urgency of stroke symptoms and the importance of calling 911 and need to be broad-based, encompassing not only those at high risk for stroke but also their friends and family. *(Stroke. 2000;31:2591-2596.)*

**Key Words:** cerebrovascular disorders ■ emergency medical services ■ stroke onset ■ stroke, acute

**Stroke** is a major cause of disability and death in the United States, with ~600 000 strokes and 160 000 deaths occurring annually.¹ Event rates and case fatality have been declining. New evidence, however, suggests that the rate of improvement has decreased in recent years.² Until recently, treatment of acute strokes has been mainly supportive. Although the National Institute of Neurological Disorders and Stroke rt-PA trial provided evidence that thrombolytic therapy for acute stroke can improve neurological outcome, such therapy is time dependent.³ Current guidelines from the American Heart Association recommend thrombolytic therapy treatment within 3 hours of the onset of symptoms and caution that the benefit of such therapy for ischemic stroke beyond 3 hours from the onset of symptoms has not been established.⁴ Additionally, recommendations for the establishment of primary stroke centers to improve acute stroke care have recently been published, stressing the importance of rapid and efficient treatment of stroke patients.⁵ Consequently, timely medical attention for patients with acute stroke is increasingly critical. An association between early arrival and the use of emergency medical services (EMS) has been found in some studies⁶⁻¹⁰ but not in all.¹¹,¹² Other studies have found an association between referral pattern and early arrival.¹³⁻¹⁷ Patients whose first medical contact was with 911 or EMS arrived at the hospital faster than did patients whose first medical contact was with a personal physician or a study hospital.¹³⁻¹⁷ Use of 911/EMS transport has also been associated with decreased in-hospital delay, including time to physician evaluation⁸,¹¹,¹₈ and time to CT scan.¹₈ Two of these studies examined predictors of EMS use and found that patients who arrived by ambulance had more severe strokes,¹⁰ were older, more likely to be black, and more likely to have blood discernible on the initial CT.¹³ The present study examines EMS use in a prospective study of individuals arriving at emergency departments (EDs) with symptoms of stroke. Prehospital and in-hospital delay among those who did and did not use EMS was compared. Potential predictors of EMS use were examined by both univariate and multivariate analyses. It was hypothesized that...
patients expressing a greater sense of urgency about their symptoms, patients who had another person first identify that there was a problem, and older patients would be more likely to use EMS, whereas patients expressing more concerns about seeking health care and patients living alone would be less likely to use EMS. It was also hypothesized that there would be little association between knowledge of stroke symptoms and EMS use.

Subjects and Methods

Study Design
A prospective registry of patients presenting to the ED with signs or symptoms suggestive of stroke was established in 3 study centers. The institutional review board on human participants in research at each center approved the study protocol. Participants or next of kin gave informed consent to be interviewed and to have their medical records abstracted.

Study Setting and Population
The present study was conducted in 7 hospitals in 3 cities: Denver General Hospital, St Joseph’s Exempla Hospital, and University of Colorado Health Sciences Center in Denver, Colo; Allen Bennett Hospital, Greenville Memorial Hospital, and Hillcrest Hospital in Greenville, SC; and the University of North Carolina Hospital, Chapel Hill.

The University of North Carolina Hospital is a university-based tertiary care facility that also serves as the primary care facility for tertiary care facility that also serves as the primary care facility for the surrounding area. The ED volume is \( \approx 38,000 \) adult patients per year, with \( \approx 230 \) patients with a discharge diagnosis of stroke admitted through the ED each year. Greenville Memorial Hospital is a tertiary care facility with an ED volume of 65,000 per year, with \( \approx 600 \) patients with acute stroke admitted each year. Allen Bennett and Hillcrest Hospital are 2 suburban hospitals with ED volumes <20,000 per year. University Hospital in Denver, Colo, is a university-based hospital with a total ED volume of 34,000 per year, with \( \approx 140 \) patients with acute strokes admitted through the ED each year. Denver General Hospital and St Joseph’s Exempla Hospital are affiliated private institutions in the Denver area.

Between October 1997 and December 1998, trained ED staff nurses enrolled 617 patients presenting with any of the following symptoms suggestive of stroke: sudden unilateral weakness or numbness of face, arm, or leg; sudden dimness or loss of vision; loss of speech; sudden severe headache; or unexplained dizziness. These broad criteria, based on symptoms at presentation and not on the hospital discharge diagnosis, resulted in the enrollment of many patients who ultimately were not diagnosed as having stroke. These sensitive criteria, however, allowed for the characterization of care-seeking behavior among a full spectrum of patients responding to stroke-like symptoms. It is estimated that the enrolled patients represent 33% of all eligible patients with stroke-like symptoms.

Measurement
During case enrollment, a trained nurse conducted with the patient or proxy a 20-minute interview consisting of information on demographics, time of onset of symptoms, nature of initial response, time to contacting healthcare system, symptom recognition, knowledge and attitude about stroke, and barriers to seeking care. Study personnel tracked the course of the patient in the ED, noting the time to being seen by a physician, time to CT scan, time to being seen by a neurologist, and treatments received.

After each patient was discharged from the hospital, the medical records were obtained and abstracted for information on healthcare utilization while the patient was in the hospital as well as the final hospital discharge diagnosis. Medical records were obtained for 609 of the 617 patients enrolled. Clinical diagnoses (transient ischemic attack [TIA], ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, and nonstroke) were determined through review of the discharge survey from the medical records and other pertinent information by a single neurologist (A.H.).

Race and prior history of stroke were obtained from the medical records. Patients were determined to have knowledge of stroke symptoms if they correctly named at least one stroke symptom (dizziness, loss of speech, numbness in arms or legs or face, weakness, headache, visual disturbance, paralysis, motor deficit, facial palsy, confusion, or disorientation) in response to an open-ended question. Patients were asked whether they had previously been told that they were at high stroke risk and whether they had previously received information about stroke symptoms. Potential barriers to timely access to medical care were established by asking the patient whether any of the following applied to him/her: (1) "didn’t think symptoms were serious," (2) "didn’t want to bother my physician," (3) “concern for cost,” (4) “bad prior experience with hospitals/physicians,” and (5) “did not believe there was anything to help me.” Patients were also asked the following: “On a 1 to 10 scale, how urgent did you believe it was that you seek medical care for these symptoms?” Patients giving a response of 10 were considered to express a high sense of urgency and were compared with patients giving a response of 1 through 9. Questions regarding age, living alone, the identity of the person who first noticed symptoms (patient or bystander), time of day of the onset of symptoms, educational level, and location of the patient at the time of symptom onset (eg, at home or work) could be answered by either the patient or a proxy.

Symptom onset was obtained during the interview of the patient or proxy in the ED. If symptoms occurred during sleep, the onset time was the last time known to be symptom free. Time to seeing an ED physician (EP) was defined as the time from arrival in the ED (first time recorded in ED, usually triage or registration) until first being seen by an EP. Time to CT scan was defined as the time from ED arrival to completion of the CT scan. Time to seeing a neurologist was defined as the time from ED arrival until first contact with a neurologist.

Data Analysis
Seven patients with missing information on EMS use were excluded. Fifty-one patients with prehospital delay periods >48 hours were also excluded, leaving 559 patients for these analyses. For statistical tests, an \( \alpha \) level of 0.05 was considered statistically significant. Univariate associations of categorical variables with EMS use were evaluated by \( \chi^2 \) tests. Because of the skewed distribution of the delay times, the Wilcoxon rank sum test was used for comparisons of time differences. For multiple pairwise comparisons, the Scheffé method was used, with the corresponding probability value adjusted for multiple comparisons. Associations of factors with EMS use were obtained from multiple logistic regression, adjusted for age and study center. Factors examined were age, sex, race, prior history of stroke, living alone, identity of the person who first noticed symptoms (patient or bystander), stroke type, knowledge of stroke symptoms, having been told that the symptoms were serious, having previously received information about stroke symptoms, 5 potential barriers to seeking care, and sense of urgency. There was insufficient data to determine severity and its association with EMS use. All analyses were performed by use of SAS Version 6.12 (SAS Institute).

Results
Of the 559 patients included in the analysis, 212 (39%) had a diagnosis of ischemic stroke; 21 (4%), intracerebral hemorrhage; 2 (0.4%), subarachnoid hemorrhage; 122 (22%), TIA; and 194 (35%), diagnoses other than stroke. Eight were missing medical records and thus were not given clinical diagnoses. Twenty-five percent of interviews were completed by a proxy. Those patients discharged with a diagnosis other than stroke or TIA had a variety of diagnoses, including migraine, drug toxicity, syncope, seizure, other neurological disorders, and ill-defined conditions. The mean ± SD age of the participants was 68 ± 15 years, 56% were female, and
Patients who used EMS had significantly shorter times from symptom onset to arrival, time to seeing an EP, time to CT scan, and time to being seen by a neurologist (Table 3). Patients who used EMS were also significantly more likely to arrive within 2 hours ($P=0.012$) and 3 hours ($P=0.035$) than were patients who did not use EMS.

EMS use was highest among those with intracerebral hemorrhage (71%), followed by those with ischemic stroke (60%), those with nonstroke diagnoses (43%), and those with TIA (39%). By use of the Scheffé method to adjust for multiple comparisons, EMS use was statistically different only between those with TIA and those with ischemic stroke ($P=0.005$) and between those with nonstroke diagnoses and those with ischemic stroke ($P=0.021$).

After adjusting for study center, age was predictive of EMS use, with older patients more likely to use EMS than younger patients (OR for each 5-year increase 1.21, 95% CI 1.14 to 1.29). The remaining models were adjusted only for age and study center. Sex (OR 1.20, 95% CI 0.84 to 1.72) and race (OR 1.52, 95% CI 1.00 to 2.31) did not predict EMS use. Patients with better knowledge and access to information regarding stroke symptoms were not more likely to use EMS. Surprisingly, those with knowledge of stroke symptoms (OR 0.63, 95% CI 0.40 to 0.98) and those who reported having previously received information about stroke symptoms (OR 0.59, 95% CI 0.38 to 0.91) were less likely to use EMS. Similarly, those who reported a bad prior experience with physicians or hospitals were less likely to use EMS (OR 0.37, 95% CI 0.15 to 0.89). Those who lived alone were also less likely to use EMS (OR 0.63, 95% CI 0.41 to 0.96).

A heightened sense of urgency about the symptoms was associated with greater EMS use (OR 1.69, 95% CI 1.09 to 2.62), whereas concern for cost was not (OR 0.85, 95% CI 0.43 to 1.71). Another strong predictor of EMS use was having someone other than the patient first identify that there was a problem (OR 2.35, 95% CI 1.61 to 3.44). There was no association between EMS use and history of stroke, educational level, time of day of symptom onset, day of the week of symptom onset (weekend or weekday), or location of symptom onset (eg, at home or at work).

When the analyses were restricted to those with confirmed strokes or TIA (n=358), the ORs remained essentially unchanged. The associations between knowledge of stroke symptoms and EMS use (OR 0.73, 95% CI 0.41 to 1.31), between sense of urgency and EMS use (OR 1.44, 95% CI 0.84 to 2.47), and between living alone and EMS use (OR 0.66, 95% CI 0.38 to 1.13) were slightly attenuated.

### Discussion

The use of EMS by patients with stroke symptoms markedly decreased both prehospital and in-hospital delay. Older people were more likely to use EMS, as were individuals with diagnoses of ischemic stroke and intracerebral hemorrhage. After adjusting for age and study center, an important predictor of EMS use was having someone other than the patient first identify that there was a problem. The individual’s sense of urgency was also an important predictor in the entire study population, although its importance was diminished when restricted to confirmed strokes/TIAs. Reporting a
bad prior experience with physicians and/or hospitals was associated with statistically significantly decreased EMS use. Knowledge and awareness of stroke symptoms was not associated with increased EMS use. Factors related to timely access to medical care for stroke symptoms are important because they may represent opportunities to reduce delays by guiding intervention strategy or identifying groups that are in particular need of intervention.

Prehospital Delay
Shorter transport time is probably not the primary determinant of the association of EMS use with reduced prehospital delay time. Previous studies have shown that travel time to the hospital is actually a small proportion of the total prehospital delay period. Because transport time is not the major component of prehospital delay,7 the majority of the reduction in prehospital delay due to EMS use must be attributed to other factors. People who perceive their symptoms (or the symptoms of someone around them) as serious and urgent are likely both to take quick action and to call 911. In contrast, those who do not think their symptoms represent an emergency are more likely to wait before taking any action and are less likely to call 911. Accordingly, we found that those who expressed the greatest sense of urgency were more likely to use EMS than those who expressed less urgency.

In-Hospital Delay
There are several possible explanations for the shorter in-hospital delay for those who use EMS compared with those who do not use EMS. The first may be that patients arriving by EMS are most often placed directly in a bed and are available to be seen by an EP immediately, whereas patients arriving via the front door must first be triaged before they can physically be brought to a bed. Registration delays or lack of recognition of the urgency of the problem at triage could further add to the delay.18 In addition, it is possible that the mere fact of arriving by EMS raises the level of concern for the patient by the physicians and ED staff.

Alternatively, patients arriving by EMS may be more severely ill and thus naturally would be seen by an EP sooner.10 Although the present study attempted to measure severity by use of both the Barthel Index20 and the Orpington Prognostic Scale,21 the large number of missing values made it impossible to adequately test this hypothesis. However, type of stroke was strongly associated with EMS use. Patients with hemorrhagic stroke were more likely to use EMS than

### TABLE 2. Patients’ Knowledge, Awareness, History, and Attitudes Concerning Stroke

<table>
<thead>
<tr>
<th>EMS Use Among Responses, %</th>
<th>Total, n</th>
<th>Yes Answers, %</th>
<th>Yes</th>
<th>No</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of stroke</td>
<td>552</td>
<td>27.2</td>
<td>50.0</td>
<td>47.5</td>
<td>0.603</td>
</tr>
<tr>
<td>Correctly identified a stroke symptom</td>
<td>443</td>
<td>69.3</td>
<td>38.1</td>
<td>50.0</td>
<td>0.019</td>
</tr>
<tr>
<td>Told at high risk for stroke</td>
<td>456</td>
<td>38.4</td>
<td>39.4</td>
<td>44.5</td>
<td>0.289</td>
</tr>
<tr>
<td>Reported to have previously been given information about stroke symptoms</td>
<td>442</td>
<td>38.0</td>
<td>36.9</td>
<td>46.0</td>
<td>0.061</td>
</tr>
<tr>
<td>Expressed high sense of urgency</td>
<td>445</td>
<td>33.7</td>
<td>45.3</td>
<td>39.3</td>
<td>0.224</td>
</tr>
<tr>
<td>Reasons for delay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Didn’t believe there was anything to help me</td>
<td>393</td>
<td>7.4</td>
<td>44.8</td>
<td>39.0</td>
<td>0.538</td>
</tr>
<tr>
<td>Bad prior experience with hospitals/physicians</td>
<td>394</td>
<td>9.1</td>
<td>22.2</td>
<td>40.8</td>
<td>0.030</td>
</tr>
<tr>
<td>Didn’t think symptoms were serious</td>
<td>414</td>
<td>37.4</td>
<td>37.4</td>
<td>40.5</td>
<td>0.530</td>
</tr>
<tr>
<td>Didn’t want to bother my physician</td>
<td>394</td>
<td>12.9</td>
<td>39.2</td>
<td>39.4</td>
<td>0.984</td>
</tr>
<tr>
<td>Concern for cost</td>
<td>395</td>
<td>12.4</td>
<td>30.6</td>
<td>40.5</td>
<td>0.187</td>
</tr>
</tbody>
</table>

*χ² test comparing EMS use among yes responses and no responses.

### TABLE 3. Median (Interquartile Range) Delay Times by EMS Use

<table>
<thead>
<tr>
<th>Time Lapse</th>
<th>Total</th>
<th>EMS Use</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms to arrival, h</td>
<td>3.50 (1.40–9.10)</td>
<td>2.85 (1.15–7.42)</td>
<td>4.08 (1.70–10.97)</td>
</tr>
<tr>
<td>≤2 h, %</td>
<td>36.1</td>
<td>41.7</td>
<td>31.2</td>
</tr>
<tr>
<td>≤3 h, %</td>
<td>47.3</td>
<td>52.2</td>
<td>43.0</td>
</tr>
<tr>
<td>Arrival to EP, h</td>
<td>0.31 (0.08–0.63)</td>
<td>0.17 (0.03–0.40)</td>
<td>0.50 (0.23–0.83)</td>
</tr>
<tr>
<td>Arrival to CT scan, h</td>
<td>1.46 (1.00–2.18)</td>
<td>1.27 (0.83–2.00)</td>
<td>1.62 (1.18–2.33)</td>
</tr>
<tr>
<td>Arrival to neurologist, h</td>
<td>2.43 (1.35–3.57)</td>
<td>2.13 (1.17–3.27)</td>
<td>2.73 (1.83–3.70)</td>
</tr>
</tbody>
</table>

Values are median (interquartile range) or as indicated.
*Wilcoxon rank sum test, except where noted.
†χ² test.
were patients with ischemic stroke, and patients with either hemorrhagic or ischemic stroke were more likely to use EMS than were those with TIA. This supports the theory that patients who use EMS have more severe symptoms than patients not using EMS. Other studies suggest that severity does have a role in rapid response within the ED. Kohari et al. found that patients arriving by Basic Cardiac Life Support transport had longer times to seeing EPs than did those arriving by Advanced Cardiac Life Support transport, indicating that the severity of the patient’s illness cannot be dismissed as a factor influencing delay.

The present study supports our previous work indicating that time from the onset of symptoms may also play a role in the perception of severity by the ED staff. Regardless of their beliefs about the usefulness of tissue plasminogen activator for ischemic stroke, the ED staff may regard someone whose symptoms have been present for only 1 hour as being different from someone whose symptoms have been present for >1 day. The data reported suggest that the time to being seen by an EP is decreased for those presenting within 3 hours of the onset of symptoms. However, as seen in our previous work, arrival by EMS still resulted in decreased times to seeing an EP and to time to CT, regardless of the length of out-of-hospital delay.

Associations With EMS Use
The direct association of age with EMS use replicates the findings of Barsan et al., as did the lack of an association with the sex of the patient. In contrast to their findings, however, no association with race was found. A strong predictor of EMS use was having somebody other than the patient first identify that there was a problem. The key role of witnesses has been reported by others.

Patients with greater knowledge and awareness of stroke and its symptoms were not more likely to use EMS. In fact, those with knowledge of stroke symptoms and who reported having previously received information about stroke symptoms were less likely to use EMS. This is in agreement with findings by others that knowledge of stroke symptoms does not decrease delay time. It is possible that the lack of an association between knowledge of stroke symptoms and delay time is due to inadequate measurement of knowledge. In addition, having a history of stroke did not have an effect on EMS use. Other studies have found that a history of stroke does not decrease delay time.

When patients are given information about stroke, more emphasis needs to be placed on the “call to action” and the emergency nature of stroke symptoms.

Limitations and Strengths
Prospective ED registries of specific patient complaints are subject to advantages and limitations of data collection in a critical care environment. One limitation was that many of the patients were incapable of completing an interview and that responses from proxies were used. This could influence the validity of some of the data collected. However, every effort was made by the nurses in the ED to interview the informant most familiar with the circumstances surrounding the onset of symptoms. More important, many of the questions (eg, about sense of urgency and concerns that might lead to delay) could be answered only by the patient. Therefore, these questions are subject to a large number of missing values, and the distribution of missing values is biased, with the most severely disabled patients being much more likely to have missing values. For example, 10% of patients with a diagnosis of TIA were missing responses to the sense-of-urgency question, whereas 24% and 30% of patients with ischemic stroke and hemorrhagic stroke, respectively, had missing responses. It is unclear how the bias may affect the results of the present study.

Nevertheless, a significant strength of the present study stems from its use of a standardized prospective interview questionnaire, instead of relying solely on medical record review. Such a review is often inadequate to obtain detailed data on the timing of symptom onset. The hospitals included in the present study represent a mix of urban and rural hospitals and of research and community hospitals in 3 geographic locations. The study population included roughly equal numbers of men and women and a substantial proportion of nonwhite participants. Consequently, these findings probably have broader generalizability.

Conclusions
EMS was underused in this population with stroke symptoms, with less than half of the participants using EMS. Only sixty percent of those with ischemic stroke used EMS. If the factors that influence EMS use can be better understood, interventions could be developed to increase EMS use among this population. The results from the present study confirm findings that knowledge of stroke symptoms is not sufficient to prompt people to take action. The patient’s own sense of urgency about his or her symptoms and having a bystander first identify that there was a problem were much more important factors. Consequently, interventions aimed at increasing EMS use among stroke patients need to stress the urgency of stroke symptoms and the importance of calling 911 and need to be broad-based, encompassing not only those at high risk for stroke but also their friends and family members.

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