Factors Associated with Hospital Arrival Time for Stroke Patients

Lenora M. Maze, Tamilyn Bakas

Abstract: Patients who experience a sudden ischemic stroke can benefit from administration of intravenous tissue plasminogen activator (tPA) to reduce the resulting disability, yet few arrive in time to be eligible for tPA administration. The purpose of this study was to determine (a) the stroke warning signs that most commonly result in the decision to seek hospital care, (b) who makes the decision to seek hospital care, (c) the most common mode of transportation to the hospital, (d) hospital arrival time in relation to the onset of the first warning sign, and (e) factors most associated with hospital arrival time for stroke survivors. Using a descriptive, cross-sectional design, data from a convenience sample of 50 stroke survivors and/or their companions (family, friends, or others seeking hospital care for the patient) were obtained by face-to-face interview during the patient’s hospital stay using a structured interview guide developed by the investigator. The most common stroke warning sign resulting in the decision to seek medical care was sudden confusion and trouble speaking or understanding speech, followed by sudden numbness or weakness on one side of the body. Patients themselves were the most common initiators of care, followed by spouses, other relatives, and others. A majority of patients arrived by ambulance, followed by private car or taxi. Only 28.9% of patients arrived at the hospital within 3 hours of the first warning sign, with the mean arrival time for the group being 330.4 minutes (5.5 hours). Mode of transportation and perceived adequacy of income were the only significant factors associated with hospital arrival time, with no significant interaction effects. Patients arriving by private car or taxi and those perceiving their incomes as comfortable lead the longest arrival times, suggesting public education efforts also should target people from higher socioeconomic groups. The nonsignificant associations between hospital arrival time, warning signs, and other demographic characteristics of initiators suggest there may be other unmeasured behavioral factors that play a more important role in reducing hospital arrival time for stroke patients. Further study of additional factors associated with early hospital arrival time is recommended to support educational efforts for early stroke treatment and prevention.

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Stroke is currently the third-leading cause of death in the United States (American Heart Association, 2002), with stroke mortality projected to double during the next 30 years (Elkins & Johnston, 2003). Even more frightening is the morbidity resulting from stroke. It is a leading cause of severe, long-term disability, with up to 30% of stroke patients becoming permanently disabled, and 20% requiring institutional care 3 months after stroke (American Heart Association). Both direct and indirect costs for stroke, including loss of productivity for morbidity and mortality, were expected to total $51.2 billion in 2003 (American Heart Association).

Although the number of people affected by stroke is large, the public’s awareness of stroke symptoms and the need for immediate treatment evaluation is poor (Hickebottom & Morgenstern, 2002; Williams, Bruno, Rouch, & Marriott, 1997). The five most common warning signs of stroke are: (a) sudden numbness or weakness of the face, arm, or leg (especially on one side of the body); (b) sudden confusion, trouble speaking, or understanding speech; (c) sudden difficulty seeing in one or both eyes; (d) sudden difficulty walking, dizziness, or loss of balance or coordination; and (e) sudden severe headache with no known cause (National Institute of Neurologic Disorders and Stroke, 2003). Panchioli et al. (1998) found that 57% of the general public was able to identify only one of the warning signs of stroke, 28% were able to identify two signs, and only 8% were able to identify three signs. Although Schneider and colleagues (2003) reported a significant improvement in the identification of warning signs by the general public between 1995 and 2000, those who are most at risk for stroke, such as people older than 75 years, African-Americans, and males, are the least knowledgeable about the warning signs and risk factors for stroke (Schneider et al.).

Lack of public awareness about the emergent nature of stroke warning signs can delay stroke patients seeking medical attention (Hickebottom & Morgenstern, 2002; Williams et al. 1997). The availability of thrombolytic therapy has brought with it a need to shorten the length of time it takes a person to reach the hospital after experiencing one or more warning signs of a stroke. The time window for intravenous administration of tissue plasminogen activator (tPA) is 3 hours from the time of onset of the first warning signs until drug infusion (Lewandowski & Lotfipour, 2002; Menon, Pandey, & Morgenstern, 1998). This period includes time for recognition of warning signs, getting to the hospital,
preliminary diagnosis of stroke by the emergency department physician, completion of a head computed tomography (CT) scan, reading of the CT scan by a neurologist or radiologist, and administration of tPA if appropriate.

Accomplishing all of these things within 3 hours requires early hospital arrival time and prompt action by healthcare providers once the patient has arrived. Although recent treatment options include the administration of intraarterial tPA, which can extend the time window to 6 hours, this intervention is limited to specialized institutions. Consequently, early hospital arrival time is still essential (Jovic, Gebel, & Wechsler, 2002). Studies have documented that fewer than half of stroke patients are admitted within 3 hours. Kothari et al. (1999) found only 30% of their stroke patients arrived in 3 hours, and Williams et al. (1997) found that less than 25% arrived within 3 hours. More recently, Lacy and colleagues (2001) found that 46% of stroke patients arrived to the emergency room within 3 hours. These findings suggest a need for further information about factors associated with early hospital arrival. More information about these factors may guide public educational efforts in this context.

The purpose of this study was to determine (a) the warning signs that most commonly result in the decision to seek hospital care, (b) who makes the decision to seek hospital care, (c) the most common mode of transportation to the hospital, (d) hospital arrival time in relation to the onset of the first warning sign, and (e) the factors most associated with hospital arrival time for stroke patients. Exploring these areas will provide health professionals with the information they need to develop educational initiatives to improve hospital arrival time for stroke patients.

Five research questions were addressed by this study:

1. What are the most commonly recognized warning signs that result in decisions to seek hospital care for stroke patients?
2. What are the demographic characteristics (relationship, gender, education, employment, perceived adequacy of income, race, and age) of initiators who seek hospital care for stroke patients?
3. What modes of transportation do stroke patients use to arrive at the hospital (ambulance, private vehicle, taxi, other)?
4. What is the average hospital arrival time in relation to the onset of the first warning sign for stroke patients?
5. Which warning signs, demographic characteristics, and modes of transportation are most associated with hospital arrival time for stroke patients?

The conceptual model in Fig 1 depicts the relationships among the variables proposed in this study. The warning signs include those identified by the National Institute of Neurological Disorders and Stroke (NINDS; www.ninds.nih.gov). The initiator is the person who made the decision to seek hospital care for the stroke patient. This person may be the patient, a family member, a coworker, or any other individual. Demographic characteristics of the initiator included gender, education, employment status, income, age, and race. The mode of transportation to the hospital could have been through activation of the emergency medical system (EMS) by calling 911 for an
Ambulance, or by private vehicle, taxi, or another mode of transportation. Hospital arrival time is defined as the amount of time from the onset of the first warning sign until arrival at the hospital in minutes.

**Background**

It is surprising that only 25%–46% of stroke patients have arrived at the hospital within 3 hours after experiencing one or more warning signs of stroke given the seriousness of the condition and the potential for long-term disability or death (Kothari et al., 1999; Lacy et al., 2001; Williams et al., 1997). In two studies, the median hospital arrival times for stroke patients ranged from approximately 4.5 to 5.5 hours, clearly exceeding the 3-hour time window for the administration of tPA (Kothari et al.; Menon et al., 1998). Current literature regarding hospital arrival times for stroke patients focuses on the recognition of warning signs, modes of transportation, and characteristics of initiators as factors that delay treatment.

**Recognition of Warning Signs**

Lack of public awareness of the warning signs of stroke has been associated with delays in seeking medical attention (Hickenbottom & Morgenstern, 2002; Schroeder, Rosamond, Morris, Everson, & Hinn, 2000; Williams et al., 1997). Pancholi et al. (1998) found that only 57% of people responding to telephone surveys were able to list even one of the five warning signs identified by NINDS. 28% were able to identify two signs, and only 8% were able to identify three signs. Interestingly, more people incorrectly listed chest pain as a warning sign for stroke than the more common warning sign of unilateral weakness (Pancholi et al.). As a follow-up to this study, Schneider et al. (2003) found the identification of at least one warning sign for stroke improved from 52% in 1995 (as found in Pancholi’s 1998 study) to 70% in 2000 (p < .001; Pancholi). Despite this improvement, knowledge regarding the risk factors for stroke remained unchanged (Schneider et al.). Schneider et al. also pointed out that elderly persons, African-Americans, and men are the least knowledgeable about the warning signs of stroke, although they are more at risk for stroke. Williams et al. found that although 38% of their study group patients admitted with stroke said they knew the warning signs of stroke, only 25% had been able to recognize their own warning signs. Warning signs resulting in delayed hospital arrival times included impaired vision, unsteadiness, and headache (Smith et al., 1998). Schroeder and colleagues found the perceived seriousness of stroke warning signs, rather than recognition alone, was a key factor in EMS activation and quicker hospital arrival times for stroke patients.

**Mode of Transportation**

Activation of the EMS has been clearly documented as the quickest mode of transportation for stroke patients. Schroeder and colleagues (2000) found a median hospital arrival delay time of 2.85 hours using EMS, compared with a delay time of 4.03 hours without EMS. Williams and colleagues (1997) found that 81% of their early arrivals (fewer than 3 hours) entered the hospital by EMS, while only 38% of the late arrivals (longer than 3 hours) entered the hospital through EMS. Given these findings, more public education has been geared toward the early recognition of warning signs, along with activation of EMS by calling 911. Despite these efforts, many stroke patients still do not arrive in time for tPA administration.

**Characteristics of Initiator**

The initiator, or the person who makes the decision to seek hospital care based on the stroke warning signs, can be either the patient, a family member, a coworker, or any other individual who sought hospital care for the patient. Identifying initiator characteristics is of prime importance in targeting educational efforts to the general public. Several studies have emphasized the role that family members play in seeking hospital care for stroke patients (Kothari et al., 1999; Schroeder et al., 2000; Wein et al., 2000). Stroke patients are much more likely to use EMS if a family member recognizes the warning signs, and family members usually are more apt to activate EMS than patients (Kothari et al.; Schroeder et al.; Wein et al.). Wein and colleagues found that 38% of their patients called a family member, a friend, their physician, or their insurance company rather than calling 911 after experiencing warning signs. On the other hand, Wein et al. found that patients who experienced a stroke while at work were 81% less likely to use EMS and were frequently driven to the hospital by coworkers. These findings underscore the need to educate the general public about stroke, rather than limiting educational efforts only to those who are most at risk for stroke.

Other demographic characteristics of initiators, such as age, gender, race, education, and perceived income, would seem to be very important in determining priority population subgroups for public educational initiatives about stroke. Although no studies were found that specifically explored gender differences, educational level, and perceived income as factors that might influence hospital arrival time, studies have reported racial differences and age as being associated with hospital arrival time (Menon et al., 1998; Schroeder et al., 2000). Menon and colleagues found that African-Americans were more likely to use EMS for transport than Hispanic-Americans or non-Hispanic whites. Consistent with these findings, African-Americans had the shortest hospital arrival times (Menon et al.). Schroeder et al. found that older patients tended to use EMS more often as a mode of transportation; however, those living alone were less likely to use EMS. More studies are needed to further explore demographic factors associated with early hospital arrival times for stroke patients.
In summary, current literature documents that fewer than half of stroke patients arrive within the 3-hour time window needed for tPA eligibility and those who arrive late often do not arrive by EMS. Studies also have documented the lack of public awareness of warning signs or the need to seek medical attention once warning signs are identified. In addition, there is some evidence that certain initiator characteristics are associated with delayed arrival time. Because of the many factors associated with delayed arrival time, studies that document factors most associated with early arrival time are needed to identify priority areas for intervention. The purpose of this study was to determine the warning signs, initiator characteristics, and modes of transportation associated with hospital arrival time in stroke patients.

Design and Methodology

A descriptive, cross-sectional design was used to identify variables that might be associated with hospital arrival time of stroke patients receiving care from two inner-city hospitals. Variables included (a) recognized warning signs, (b) demographic characteristics of the initiator (relationship, gender, education, employment, perceived adequacy of income, race, and age), (c) mode of transportation (EMS, private vehicle, taxi, other), and (d) hospital arrival time in minutes in relation to the first warning sign. The investigator obtained this information during the patient’s hospital stay. Face-to-face interviews lasting approximately 5 minutes each were conducted with stroke patients using a structured interview guide developed by the investigator. The guide included items that inquired about recognition of warning signs, demographic characteristics, mode of transportation, and hospital arrival time. Family members, friends, or anyone seeking hospital care for the patient (initiators) supplemented the information when the patient was unable to respond. Data were collected on a convenience sample of 50 stroke patients, including those who had ischemic, hemorrhagic, and transient ischemic attacks (TIAs). Further sample characteristics are described in the next section. University institutional review board approval and informed consent were obtained prior to data collection.

Results

The first research question determined the warning signs most commonly resulting in the decision to seek hospital care. Sudden confusion or trouble speaking or understanding speech was the most common warning sign, cited by 46% of initiators. Initiators included the patients, family, friends, or others who sought hospital care. The second most common sign was sudden numbness or weakness of the face, arm, or leg, especially on one side of the body, cited by 40% of the initiators. Other warning signs were sudden difficulty seeing in one or both eyes (24%), sudden difficulty walking, dizziness, loss of balance or coordination (10%), and sudden headache with no known cause (4%). Many of the initiators identified more than one of the warning signs as a reason for seeking hospital care.

The second research question examined demographic characteristics of initiators who sought care for stroke patients. Forty-two percent of the initiators were the patients themselves. Spouses represented 22% of the initiators, and other relatives, such as adult children, nieces, sisters, and other family members, represented 20% of initiators. Sixteen percent fell into the “other” category, which included friends, coworkers, health professionals, and the police. Gender of the initiators was fairly evenly distributed (52% male, 48% female), and most initiators had at least a high school education (20% less than high school, 60% high school graduate, 20% college or technical school) and were employed either full- or part-time (66%). Approximately 42% of initiators perceived their adequacy of income as “comfortable,” 40% as “enough to make ends meet,” and 18% as “not enough to make ends meet.” Ethnic self-identification was 48% Caucasian, 44% African American, 6% Hispanic, and 2% Asian. Age of initiators ranged from 22 to 81 years, with a mean age of 49.2 years. The mean age of the stroke survivors was 58 years.

The third research question addressed the type of transportation used to reach the hospital. EMS was reported by 58% of the initiators as the mode of transportation, whereas 38% of patients were transported by private vehicle and 4% arrived by taxi.

The mean hospital arrival time in minutes after the onset of the first symptom was 330.4 minutes ($SD = 329.6$, median = 300.0, mode = 60.0, range = 15-1,440),

![Table 1. Untransformed Means and Standard Deviations for Differences in Hospital Arrival Time by Mode of Transportation and Perceived Adequacy of Income](image-url)

<table>
<thead>
<tr>
<th>Perceived Income</th>
<th>Emergency Medical System</th>
<th>Private Vehicle or Taxi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Mean</td>
</tr>
<tr>
<td>Comfortable</td>
<td>292.3</td>
<td>239.2</td>
<td>678.8</td>
</tr>
<tr>
<td>Enough to make ends meet</td>
<td>139.1</td>
<td>215.6</td>
<td>319.3</td>
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<tr>
<td>Not enough to make ends meet</td>
<td>170.0</td>
<td>34.6</td>
<td>390.0</td>
</tr>
<tr>
<td>Total</td>
<td>210.2</td>
<td>221.1</td>
<td>480.8</td>
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</tbody>
</table>
which averages about 5.5 hours. Frequency distribution of hospital arrival time revealed that only 28.9% of the sample arrived at the hospital within 3 hours, indicating that a large majority of patients would not have been eligible for conventional tPA treatment. Because of the large variability, skewness, and kurtosis of hospital arrival time data, this variable was transformed to achieve normality using a square root transformation suggested by Tabachnick & Fidell (1996) prior to further analyses addressing the final research question.

The final research question was to explore factors most associated with hospital arrival time. Statistical analyses by t test were conducted to determine relationships between arrival time and each warning sign (yes/no format for each), modes of transportation (EMS versus private car or taxi), and the initiator characteristics of gender, employment (employed versus unemployed), and race (African-American versus Caucasian). One-way ANOVA determined relationships between arrival time and initiator relationships (patient, relative, other), education (less than high school, high school, college, or technical school), and income (comfortable, enough to make ends meet, not enough to make ends meet). Pearson r was used to determine the relationship between arrival time and initiator age.

Mode of transportation and perceived adequacy of income were the only two factors that achieved statistical significance. To test for interaction effects, a two-way ANOVA was performed using a two-tailed test and an alpha of 0.05 with mode of transportation and perceived adequacy of income as the independent variables. Using the transformed hospital arrival time as the dependent variable, there was a significant main effect for mode of transportation [F (1,39) = 8.54, p < .01, observed power = 0.81] and perceived adequacy of income [F (2,39) = 4.26, p < .05, observed power = 0.71]. The interaction between mode of transportation and perceived adequacy of income, however, was not significant [F (2,39) = 1.19, NS, observed power = 0.08]. The assumption for homogeneity of variance was met for all analyses using the transformed hospital arrival time.

Table 1 details the untransformed means and standard deviations of hospital arrival time by perceived adequacy of income and modes of transportation. These data show that those arriving by EMS and those who had reported their income was enough to make ends meet had the shortest arrival times. Those with the longest arrival times were those who arrived by private vehicle or taxi, and interestingly, those who perceived their income as comfortable.

**Discussion**

Although prior knowledge of the warning signs of stroke was not determined in this study, initiators reported several warning signs as reasons for seeking hospital care. Despite earlier reports of the lack of public aware-

ness of the stroke warning signs (Hickenbottom & Morgenstern, 2002; Williams et al., 1997), 42% of the initiators in this sample had recognized confusion or speech problems, 40% recognized numbness or weakness, and 24% recognized visual problems that could require hospital care. Recognizing these warning signs as reasons to seek hospital care was not significantly associated with hospital arrival time, however. This suggests other factors are more important in seeking hospital care.

A recent article published by Hickenbottom and Morgenstern (2002) might explain these findings. These authors evaluated research that explored the effects of public education on arrival time. They concluded that education related to symptoms alone is insufficient to change behaviors, and that behavioral theory is an important perspective to explore in educating the public to decrease delay time to hospital for stroke patients. An excellent example of the use of behavioral theory in educating the public about stroke is a study by Miller and Spilker (2003). They found that a brief educational intervention based on stage of readiness to change was useful in reducing stroke risk factors and increasing knowledge about stroke in 60 family-practice patients enrolled in a pilot study in which they were randomized to control, simple advice, and brief intervention groups.

Determining target populations for public educational initiatives seems important as well. Approximately 58% of the initiators in this study were family members or others. The category of the initiator (patient, family, other) was not significantly associated with hospital arrival time, however. In fact, the only initiator characteristic associated with hospital arrival time was perceived adequacy of income. The finding that those who reported their incomes to be comfortable took the longest to arrive at the hospital is surprising; however, one might speculate these initiators were likely to be insured and, therefore, might have called their physician, insurance company, or others prior to seeking hospital care, as mentioned by Wein et al. (2000). This finding underscores the importance of targeting people from all socioeconomic groups when interventions to improve hospital arrival time are being designed.

Consistent with other studies (Williams et al., 1997; Schroeder et al., 2000), stroke patients who arrived at the hospital through EMS had significantly shorter hospital arrival times. When exploring differences in hospital arrival time based on mode of transportation and perceived adequacy of income, only the main effects of these variables reached significance, with no interaction between the two variables. With the multiple factors tested in terms of hospital arrival time, only perceived adequacy of income and mode of transportation were significant, suggesting the importance of seeking other factors that can be used to develop educational interventions. These implications further support Hickenbottom & Morgenstern’s (2002) conclusion about the need to
explore behavioral theories to explain why a majority of stroke patients do not arrive at the hospital within a 3-hour period. The use of constructs such as perceived risk, benefits and barriers, readiness to change, and self-efficacy may add to our understanding of this phenomenon. Qualitative studies exploring the thoughts and actions of patients and initiators between the onset of the first symptom and hospital arrival also would be informative.

Limitations
This study used a small, convenience sample of stroke patients from two inner-city hospitals in the Midwest, limiting generalizability of the findings to other populations. Although almost-equal proportions of African-Americans and Caucasians were represented in the sample, other ethnic minorities, such as Hispanics and Asians, were not well represented. Another limitation was that the type of stroke varied, which may have influenced the findings. The interview guide also featured structured questions. Other designs using qualitative methods or those that include behavioral variables may better explain factors associated with early hospital arrival times.

Implications
Community and patient education currently is focused on teaching people about the warning signs of stroke and the need to call 911 quickly. Although these efforts are essential to educate the public, this study’s findings suggest other factors should be explored as well. Although stroke warning signs often are recognized as requiring hospital care by initiators, this study failed to find a link between this recognition and early hospital arrival time. Findings from this study did, however, indicate those with more comfortable incomes and those who were transported to the hospital by private car or taxi had the longest arrival times. These findings suggest the need to aim public educational efforts toward persons from all socioeconomic groups. Although not measured in this study, Hickenbottom and Morgenstern (2002) emphasized the need to focus on behaviors that promote early seeking of hospital care for individuals experiencing signs of stroke. Clinicians should attempt to identify other possible factors that may improve hospital arrival time for those at risk for stroke.

Summary
Despite the fact that stroke is a leading cause of severe, long-term disability (American Heart Association, 2002), public awareness of stroke’s warning signs and risk factors for stroke and the need for urgent administration of tPA is lacking. Findings from this study using a convenience sample of 50 stroke survivors and/or their companions documented that the most common stroke warning sign resulting in the decision to seek medical care was sudden confusion or difficulty speaking or understanding speech, followed by sudden numbness or weakness on one side of the body. Whether patients interpreted these warning signs as reasons to seek hospital care, however, was not associated with early hospital arrival time. Patients themselves were the most common initiators of care, followed by spouses, other relatives, and others. The only significant demographic characteristic of initiators associated with hospital arrival time was perceived income level, with those perceiving their incomes as “comfortable” having the longest arrival times.

A majority of patients arrived by ambulance, with those arriving by private car or taxi having significantly longer arrival times. Only 28.9% of patients arrived at the hospital within 3 hours of the first warning sign, with the average time being 330.4 minutes (5.5 hours). This study underscored the need to include people from all socioeconomic levels when public educational efforts to promote stroke awareness and the need for early treatment are being developed. Because of the lack of significance in exploring warning signs and other demographic characteristics, professionals are urged to consider other possible factors associated with early hospital arrival times for stroke patients. Although not measured in this study, behavioral constructs such as perceived risk, benefits and barriers, readiness to change, and self-efficacy are areas that may be effective in designing intervention programs to educate the public about stroke (Hickenbottom & Morgenstern, 2002; Miller & Spilker, 2003).

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References

continued on page 155
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continued from page 141


